1986 NATIONAL SCIENCE FOUNDATION AUTHORIZATION

HEARINGS

BEFORE THE

SUBCOMMITTEE ON
SCIENCE, RESEARCH AND TECHNOLOGY

OF THE

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SCIENCE AND TECHNOLOGY
HOUSE OF REPRESENTATIVES

NINETY-NINTH CONGRESS

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[*] Ranking Republican Member.

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1986 NATIONAL SCIENCE FOUNDATION AUTHORIZATION

WEDNESDAY, FEBRUARY 6, 1985

House of Representatives,
Committee on Science and Technology,
Washington, DC.

The committee met, pursuant to call, at 1:30 p.m., in room 2318, Rayburn House Office Building, Hon. Don Fuqua (chairman of the committee) presiding.

Present: Mr. Fuqua, Mr. Brown, Mr. Walgren, Mr. Nelson, Mr. McCurdy, Mr. Mineta, Mr. Bruce, Mr. Lujan, Mr. Walker, Mr. Sensenbrenner, Mr. Boehlert, Mr. Packard, Mrs. Meyers, Mr. Smith, Mr. Henry, Mr. Cobey, and Mr. Slaughter.

The **Chairman**. The committee will be in order.

We want to welcome Mr. Bloch to the Committee on Science and Technology.

Our hearing today is the third in the Science and Technology Committee's series of posture hearings on the administration's fiscal year 1986 budget proposals for research and development. Yesterday, Dr. Keyworth, the President's Science Adviser, reviewed for us the administration's philosophy, rationale, and proposed investment for science and engineering in fiscal year 1986.

[The prepared opening statement of Mr. Lujan follows:]

Thank you, Mr. Chairman. I would like to welcome Mr. Bloch to this committee and I welcome his perspective as director of the National Science Foundation.

Unlike many other government agencies, the NSF has received very generous budget increases. These increases, I believe, are a recognition of the importance of basic scientific research to the United States. This year, in spite of the budget freeze, the NSF has been fortunate to receive a 4.4 percent increase. We see increases in programs to enhance U.S. economic competitiveness, upgrade science and engineering education and bolster support for academic research.

We also see increased support for computer sciences and related research. This country continues to hold the lead in the rapidly advancing field of computer technology and that is a lead that I do not want to ever see us lose.

Mr. Chairman, I support the basic goals and programs of the NSF and I believe they provide this country with the catalyst for basic research and a needed increase in science and engineering education.

At a time when we are examining budgets for all federal agencies and having to hold the line on some and make cuts on others, I think a 4.4 percent increase is a modest, and needed, investment for the scientific and technological future of this country.

The **Chairman**. Mr. Bloch, we are very happy to have you.

Mr. Walgren, do you have an opening statement? Mr. Walgren is chairman of the Subcommittee on Science Research and Technology.

Mr. **Walgren**. Thank you, Mr. Chairman.

I would like to second the welcome of the chairman of the full committee to our process, and express the interest of particularly the members of my subcommittee that have the authorizing first cut at your proposals.

We really do feel deeply that, as I know you do, Dr. Bloch, the National Science Foundation has the most central role to play in assuring and promoting the scientific health of the country. The charter of the National Science Foundation literally charges it with the responsibility for the health of science in our country.

We have a lot of areas that need attention, and of course, we are using a relatively small program, and small targeted effort to try to give it that attention.

This committee has been particularly interested in the deficiencies in science and engineering education, and the Congress as a whole responded in one of the few initiatives last year with a major authorization to do more in science and engineering education, and we are most interested in your engineering centers, in that program, and what it can contribute.

The proposals that you will be administering in advanced scientific computing are ones that have caught our attention, and we want to see them successful, and we want to see the program move along directly.

There is just so much that is within your range that is critical to the national interest, that you will find a very interested and supportive group when you come to the Hill, I believe.

We welcome you in that sense and look forward to interacting with you in the hopes of contributing something to the process from our end, and helping you do the best that can possibly be done.

Mr. Bloch. Very good.

[The prepared opening statement of Mr. Walgren follows:]

OPENING STATEMENT OF REPRESENTATIVE DOUG WALGREN

As Chairman of the Subcommittee on Science, Research and Technology I want to welcome Mr. Bloch to the Committee. Since the National Science Foundation is the cornerstone of Federal support for basic scientific research at colleges and universities, its policies are of critical importance to the nation. I look forward to Director Bloch's discussion of the Foundation's policies and other related issues.

Of special importance is the issue of science and engineering education. This issue has been the focus of the Committee's attention over the past several years. Our activities culminated in the passage of Public Law 98-377, a law containing several measures to improve science education at all levels. Specifically, I am interested in the progress made in re-establishing the Science and Engineering Education Directorate. Such a step will help NSF reassume its proper role in science education based on its unique strengths.

The Foundation's initiatives in the areas of engineering research centers and advanced scientific computing are important and deserve sustained support. The Foundation's plans in these areas will have enormous impact on U.S. competitiveness in the world economy.

In general, the vitality of our national economy and our national security are both dependent upon a strong science research effort. I look forward to working with Mr. Bloch and the Foundation in providing strong and continued support for basic science research.

The Chairman. Mr. Bloch, we would be pleased to hear from you now, Mr. Bloch.

[A biographical sketch of Mr. Bloch follows:]

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20550

ERICH BLOCH
DIRECTOR

Erich Bloch was confirmed by the Senate to be Director of the National Science Foundation on August 6, 1984. As Director, he is responsible for an agency charged with strengthening the national scientific research potential, with improving science and engineering education at all levels, and with increasing the interchange of scientific information among scientists in the United States and abroad. He is also responsible for establishment and implementation of numerous bilateral science agreements with foreign nations and other major tasks related to science, engineering and technology. His responsibilities, carried out through an agency of seven major directorates, involve administration of an annual budget exceeding $1.5 billion and the annual award of 12,000 to 14,000 grants for research. Research programs are conducted in all fields of natural and social sciences and include major national and international science programs.

Before joining NSF Mr. Bloch was Vice President for Technical Personnel Development at IBM Corporation which he joined in 1952 as an electrical engineer. During his career at IBM, Mr. Bloch was the engineering manager of IBM's STRETCH supercomputer system in the late 1950's and early 1960's, developed under contract from Los Alamos Laboratory of the Atomic Energy Commission. In 1962, he headed development of the Solid Logic Technology program, which provided IBM with microelectronic technology for its System/360 computer.

In 1968, Mr. Bloch became director of IBM's Poughkeepsie (NY) laboratory, and two years later he was named Vice President of Operations for IBM Components Division.

Subsequently, Mr. Bloch was appointed a vice president of the company's Data Systems Division and general manager of the East Fishkill facility, which is responsible for the development and manufacture of semiconductor components used in most of IBM's product line. He was elected an IBM Vice President in 1981.

In his last IBM position, Mr. Bloch was charged with promoting the technical vitality of IBM's professional engineering, programming, technology, and scientific people throughout the world. His responsibilities included programs with universities, the firm's technical libraries, publication of technical journals, and the operation of IBM's corporate technical institutes. Mr. Bloch was also responsible for policies affecting the IBM science and engineering community. Mr. Bloch served as a member of the Corporation's Education Relations Board, which is responsible for IBM contributions to academic institutions.

From 1981 to 1984 Mr. Bloch served as chairman of the Semiconductor Research Cooperative, a group of leading computer and electronics firms that funds advanced research in universities and shares in the results, and was a member of the board of the Semiconductor Industry Association.

Mr. Bloch was born January 9, 1925, in Sulzburg, Germany, and became a United States citizen in 1953. He received his education in electrical engineering at the Federal Polytechnic Institute of Zurich, Switzerland, and a bachelor of science degree in electrical engineering from the University of Buffalo in 1952.

Mr. Bloch is a member of the National Academy of Engineering and is a fellow of the Institute of Electrical and Electronics Engineers and a member of its Computer Society.

He is married and has one daughter.

September 1984

STATEMENT OF ERICH BLOCH, DIRECTOR, NATIONAL SCIENCE FOUNDATION

Mr. Bloch. Thank you, Mr. Chairman, and thank you, Mr. Walgren, for your kind words, and members of the committee. I am glad to be here this afternoon to talk about the National Science Foundation, and the chairman in his letter asked me to address the contribution of science and technology to the well-being of the Nation, the role of NSF in this particular process, and the priorities and the implications of the 1986 budget, and I will try to address all of these areas.

Before I begin, I would like to show a short film which provides an overview of the research activities of the Foundation.

[Film presentation.]

Mr. Bloch. Mr. Chairman, I thought that for the new members in particular this film provides a very intimate glimpse at the wide range of research and activities supported by the Foundation.

I am the first NSF Director from industry. During my career in industry, I learned the importance of basic science and engineering research for success in the marketplace. Such research is essential for maintaining our industries at the leading edge of technology, and for the continued economic health and the national security of this Nation.

The dependency of U.S. industry on basic research is increasing for several reasons:

To stay ahead of international competition.

To have access to new materials, processes, and equipment, and the people able to apply these new technologies.

To keep up with the complexity and rapid advances in newly emerging technologies.

At the same time, there are profound issues facing the science and engineering community.

The lead of U.S. science and engineering over that of other nations is narrowing, and that has been pointed out many times before.

There is an increased realization by industrialized nations that science and technology are at the heart of economic progress.

As a result, we are beginning to see research efforts emphasized by foreign trading partners, challenging the U.S. leadership role in emerging fields such as supercomputers and biotechnology.

Emerging nations are emulating the success of industrialized nations by converting research results into marketable technology.

In order to be competitive, we must keep our research and technology on the cutting edge, and by being first in translating research results into products in the marketplace. This sounds like a simple, even a primitive formula, but I think it has been proven right for too many years.

Science and engineering itself is in transition: The rate of progress is increasing by every measure we have. So is the complexity of the scientific endeavor, its tools and methods, demanding more sophistication and higher skills by those in the forefront of research.

In emerging new technologies, such as biotechnology and computers, research is also becoming increasingly multidisciplinary, requiring different approaches and new institutional arrangements. Furthermore, it is now possible for scientific observations to be made and integrated over global scales.

A natural consequence of this change is that the total cost of research, especially instrumentation and special facilities, is increasing faster than in prior years.

At the same time, there are shortages in the science and engineering community. We need to be concerned about the decline in the proportion of U.S. citizens pursuing graduate studies in science and engineering, and the shortage of faculty in certain areas of science and engineering in U.S. universities.

This decline leads not only to a possible reduction in the quality of instruction and research, but ultimately, to a possible shortage of professional skills required by industry, government, and academia itself.

Equally important is the need to upgrade and modernize the academic research environment. Much of the equipment and instrumentation in university research laboratories are no longer the best available. Laboratory space should be able to accommodate the use of more complex processes and equipment often demanded by new and emerging research.

Scientific research requires long-term continuity, and this is quite important. The need for long-term stability is underestimated, however, many times, and not everyone realizes that the incubation period for science and engineering endeavors is long.

Over the last several years, we believe we have made the visible commitment necessary to produce the best research and generate exceptional talent, and we will continue to do so in 1986.

The National Science Foundation pursues its responsibility for the health of the general scientific enterprise by supporting the most promising fundamental, long-term research by the best minds in all fields of science and engineering.

The principal products are twofold:

New knowledge and discoveries at the cutting edge of research; and the education and training of the world's most talented and creative scientists and engineers. The two really are intertwined. In fact, they go hand in hand.

Gaining a new and deeper understanding of nature, and replenishing our supply of scientists and engineers are essential if we are to improve the Nation's industrial competitiveness, defense, economy, and health and general well-being of our citizens.

Our success will depend on how well we educate the scientists and engineers of tomorrow and how well we provide for the pursuit of new knowledge and research.

Out of a total of nearly $8 billion of basic research funded by the Federal Government, the NSF budget represents only 17 percent. The university funding, NSF represents 27 percent.

While the percentage may seem small, our research role is very important and unique. We are concerned primarily with strengthening scientific research potential and scientific education programs, and not with serving an end product mission like most other agencies engaged in research support.

NSF goals and strategies:

Let me now turn to NSF goals and strategies. This will answer the second part of your question.

The first goal is excellence. It has always been that way, and it must continue. In science and engineering research, as in any creative endeavor, the best is vastly more valuable than the merely good.

Externally, in our grants and contracts activities, excellence means merit-based peer review. It is still the best way, although not perfect, to ensure high quality and best return for the Nation's investment.

Internally to the Foundation, we will concentrate on effective and efficient management using automation where possible to increase our productivity.

The second goal is for NSF to be a catalyst for change in the science and engineering community. This means not only pursuing new research opportunities, but encouraging new ways to carry out research.

Applying interdisciplinary approaches to new and emerging research possibilities is one such way. Developing new relationships between government and private institutions, and between industry and universities.

Increasing communication among researchers in all research disciplines, and stimulating the sharing of expensive equipment, facilities and knowledge.

While we may encourage science and engineering research to move in new directions in a concerted way, we must and will continue to support individual research projects done by a principal investigator scientist and a few students. It has proven to be a simple yet most effective strategy.

The key is to balance this with large scale cooperative efforts. There is ample opportunity and need for both; it is not one approach or the other.

Third, NSF must try to improve the health of the science and engineering infrastructure. Instrumentation, specific facilities integral to research and human resources should be the best to revitalize the academic research base. We will continue to support new and enhanced instrumentation and access to it.

Fourth, we must continue to help attract, educate and train students for science and engineering. We are doing this through fellowships open to all qualified applicants; special programs addressing minorities, women, and the handicapped; programs designed to attract and retain faculty in disciplines where faculty shortages impede basic research progress; programs keyed to the improvement of precollege science and mathematics education; and increased support of graduate students through research projects.

Finally, we will continue to leverage Government funds with private sector, State and local government, and academic support in all areas where cooperation is a possibility and in the best interests of all participants.

In order to move toward these goals and given the budget environment for fiscal year 1986, the Foundation had to make decisions in order to maximize the funding available for academic science and engineering research activities. These include:

Recognizing the need and the administration's resolve to reduce NSF's administrative costs further. While NSF's administrative costs are already low compared to those of similar organizations, further efficiencies can be realized, in fact, below those of fiscal year 1985.

Curtailing programs that are not in the mainstream of scientific and engineering research.

Stretching out construction and acquisition of several major research projects including the VLBA.

Making tradeoffs with ongoing base programs in order to provide for enhancements in several key areas where research is essential to the Nation's pursuit of scientific and technological excellence and to training the next generation of scientists and engineers.

I am pleased to tell you that the NSF's fiscal year 1986 budget request continues the momentum established by this administration, and supported by Congress, to keep U.S. science and engineering research the best in the world.

The Foundation's fiscal year 1986 budget request totals $1,569.4 million or 4.4 percent above the fiscal year 1985 current plan of $1,502.7 million. It includes $1,397.8 million for research and related activities, an increase of 7.4 percent; $120.1 million for the U.S. Antarctic Program, up 8.4 percent; $50.5 million of new obligational authority for science and engineering education which, combined with a proposed deferral from 1985 of $31.5 million, provides total resources of $82 million, the same level as 1985.

This budget request, if approved by Congress, maintains support at current levels for research of proven quality across all disciplines.

It increases support for research related to U.S. economic competitiveness such as engineering research centers, and biotechnology.

It increases programs that provide essential basic support for advances in science and technology, focusing, in addition to the research, on instrumentation and specific facilities that are an integral part of the proposed research.

Some activities, however, such as the construction of the Very Long Baseline Array, will continue, but at a somewhat slower pace than originally planned due to budget constraints.

It also focuses Presidential Young Investigator Awards on younger faculty than in previous years and provides an additional $6 million to support 100 new awards in 1986, bringing the total to 500.

These are some of the highlights of our 1986 request. I expect to discuss the budget in greater detail at the upcoming authorization hearing. However, there are several areas that I would like to talk about today.

While the United States is currently the world leader in most aspects of biotechnology, we cannot take that leadership role for granted. The basis for our leadership is very fragile, and we must continue to work hard to maintain it through Federal, industrial and academic efforts, individually and in partnership.

NIH, USDA, DOE, and DOD support biotechnology research related to problem-oriented applications. NSF, however, has a unique role to play in expanding fundamental knowledge, encouraging new multidisciplinary research opportunities and, importantly, producing the necessary talent in biotechnology.

Also, we have experience in dealing with the multidisciplinary approach that is necessary for rapid progress in biotechnology research, and essential for training our best students in biology, chemistry, chemical engineering and plant science.

NSF is also the primary Federal supporter of basic research in systematics and ecology. This research forms the scientific base necessary to assess the potential environmental impact of the various products and byproducts of biotechnology.

Our leadership role in science and engineering research depends on stimulating and maintaining an adequate supply of talented young students and graduates. NSF plays a limited but catalytic role at all educational levels through direct science and engineering education programs; research grants which not only enhance education but also permit training with senior researchers and sophisticated instruments.

At the precollege level, we are placing a special emphasis on science and mathematics programs at the elementary and middle school levels to provide leadership in the training of teachers, the development of sound instructional materials, and the appropriate use of modern technology.

At the undergraduate level, we support a number of students participating in research grants, help with instructional equipment needs at the Nation's 4-year colleges, and fund faculty research projects at predominantly undergraduate institutions.

We cannot overlook these 4-year institutions, because many leading scientists and engineers receive their basic training at predominantly undergraduate schools.

Support for graduate students and postdoctorals come in large part from their participation in NSF-supported research grants. In 1986, the number of graduate students and postdocs supported in research grants is expected to increase 4 percent to a total of

14,387. We also will provide support for over 1,500 graduate research fellowships.

Finally, we provide, with matching funds and participation from the industrial sector, the Presidential Young Investigator Research Awards. These awards encourage promising young scientists and engineers to select and remain in academic careers.

Our commitment to these people is for a duration of 5 years.

Another area I want to highlight is international science.

The Foundation's international research activities are becoming increasingly important to the overall success of our science and engineering research efforts. International participation encourages cooperation and communication; provides access to special facilities, instruments and expertise located abroad; allows access to sites to observe natural and social phenomena; encourages cost sharing of large research installations; and serves to support and strengthen U.S. foreign policy objectives.

NSF, together with the Department of State, has formal bilateral agreements for cooperative research with some 30 countries, cutting across a wide range of disciplines. We also provide support to the National Academy of Sciences for cooperation with sister academies in China and Eastern Europe, and participate in such administration initiatives as the United States-India science and technology agreement.

For the most part, however, there are more informal, discipline-oriented international research activities. Two major international cooperative activities, Antarctic research and ocean drilling, together with some 700 other projects, provide $73 million for research by U.S. scientists in collaboration with scientists in other countries.

It is important for both science and engineering research and U.S. foreign policy objectives that we maintain strong international research activities. In fiscal year 1986, we propose to change the balance slightly between the formal and informal disciplinary research activities, and overall to increase our international research support, by about $5 million to $150 million.

Computers play a central and critical role in science and engineering research. As research tools, they provide new opportunities to explore, observe, and understand phenomena. In this way, computers broaden the base of science and engineering knowledge.

As a discipline, research in computational mathematics, systems and design, information science, and other areas helps expand the knowledge base from which state-of-the-art computer technology springs.

There are four major components to our computing activities:

Supercomputer facilities will make available to the research community the most advanced computing equipment. It should also stimulate the continuing involvement of U.S. industry in this important field.

Networking will link scientists and engineers, encouraging collaboration, resource sharing and rapid dissemination of research results.

Local facilities provide help with the acquisition and operation of essential computing facilities or services needed on a daily basis to carry out research.

Research on computers provides support to advance the state of the art in computer technology.

There are several agencies, DOD, DOE, NASA, and NIH, that provide similar support to scientists and engineers working on mission-specific projects relevant to those agencies.

The NSF, in this case like the biotechnology case, however, has a unique, and quite essential, role because it does not impose mission criteria in selection of the research projects. More importantly, NSF can provide support for computer research and computers across a wide spectrum of disciplines.

This has very important consequences:

First, it provides knowledge and talent that might not otherwise be available. NSF supported much of the early conceptual work in highly parallel computer architectures years before the relevance of that work to defense, energy and other missions was recognized.

In addition, training of graduate students in computer research and engineering is accomplished through NSF-supported facilities. These facilities are used extensively by graduate students to conduct research in many disciplines, research which is often NSF-supported.

Mr. Chairman, in conclusion, I want to stress that we are indeed fortunate to be at a major transition point, because with transition comes opportunities. The research environment is in transition, and with it the opportunity to push back the frontiers of science and engineering. Public attitudes toward science are changing, too. There is a growing consciousness that basic research is an essential ingredient for continued economic health, national security and quality of life.

NSF must capitalize on these opportunities. This budget request, along with your continued support, signals a strong commitment to keep U.S. scientific and engineering research and technology the world's best.

That concludes my testimony. I will be glad to answer any questions you have. Thank you very much.

[The prepared statement of Mr. Bloch and "National Science Foundaton FY 1986 Budget summary"follow:]

National
Science
Foundation

STATEMENT OF

MR. ERICH BLOCH

DIRECTOR, NATIONAL SCIENCE FOUNDATION

BEFORE THE

COMMITTEE ON SCIENCE AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

FEBRUARY 6, 1985

Mr. Chairman and Members of the Committee:

It is a pleasure to be here this afternoon to talk about the National Science Foundation.

My first five months as Director of the Foundation have been exciting, and I look forward to discussing our proposed programs for 1980 in this and forthcoming hearings.

Before I begin, I would like to show a short film which provides an overview of the research activities of the Foundation.

-FILM-

I thought that for new members in particular, this film provides an intimate glimpse at the wide range of research activities supported by the Foundation.

I. Issues in Science and Engineering

I am the first NSF director from industry. During my career in industry I learned the importance of basic science and engineering research for success in the marketplace. Such research is essential for maintaining our industries at the leading edge of technology, and for the continued economic health and the national security of this nation.

The dependency of U.S. industry on basic research is increasing for several reasons:

o To stay ahead of international competition.

- TO HAVE ACCESS TO NEW MATERIALS, PROCESSES, AND EQUIPMENT, AND THE PEOPLE ABLE TO APPLY THESE NEW TECHNOLOGIES.

- TO KEEP UP WITH THE COMPLEXITY AND RAPID ADVANCES IN NEWLY EMERGING TECHNOLOGIES.

AT THE SAME TIME, THERE ARE PROFOUND ISSUES FACING THE SCIENCE AND ENGINEERING COMMUNITY.

THE LEAD OF U.S. SCIENCE AND ENGINEERING OVER THAT OF OTHER NATIONS IS NARROWING

THERE IS AN INCREASED REALIZATION BY INDUSTRIALIZED NATIONS THAT SCIENCE AND TECHNOLOGY ARE AT THE HEART OF ECONOMIC PROGRESS. AS A RESULT, WE ARE BEGINNING TO SEE RESEARCH EFFORTS EMPHASIZED BY FOREIGN TRADING PARTNERS, CHALLENGING THE U.S. LEADERSHIP ROLE IN EMERGING FIELDS SUCH AS SUPERCOMPUTERS AND BIOTECHNOLOGY.

EMERGING NATIONS ARE EMULATING THE SUCCESS OF INDUSTRIALIZED NATIONS BY CONVERTING RESEARCH RESULTS INTO MARKETABLE TECHNOLOGY.

WE MUST CONTINUE TO BE COMPETITIVE BY KEEPING OUR RESEARCH AND TECHNOLOGY ON THE CUTTING EDGE, AND BY BEING FIRST IN TRANSLATING RESEARCH RESULTS INTO PRODUCTS IN THE MARKETPLACE.

SCIENCE AND ENGINEERING ITSELF IS IN TRANSITION

THE RATE OF PROGRESS IS INCREASING BY EVERY MEASURE WE HAVE. SO IS THE COMPLEXITY OF THE SCIENTIFIC ENDEAVOR, ITS TOOLS AND METHODS, DEMANDING MORE SOPHISTICATION AND HIGHER SKILLS BY THOSE IN THE FOREFRONT OF RESEARCH.

IN EMERGING NEW TECHNOLOGIES, SUCH AS BIOTECHNOLOGY AND COMPUTERS, RESEARCH IS ALSO BECOMING INCREASINGLY MULTIDISCIPLINARY, REQUIRING DIFFERENT APPROACHES AND NEW INSTITUTIONAL ARRANGEMENTS.

FURTHERMORE, IT IS NOW POSSIBLE FOR SCIENTIFIC OBSERVATIONS TO BE MADE AND INTEGRATED OVER GLOBAL SCALES.

A NATURAL CONSEQUENCE OF THIS CHANGE IS THAT THE TOTAL COST OF RESEARCH, ESPECIALLY INSTRUMENTATION AND SPECIAL FACILITIES, IS INCREASING FASTER THAN IN PRIOR YEARS.

THERE ARE SHORTAGES IN THE SCIENCE AND ENGINEERING COMMUNITY

WE NEED TO BE CONCERNED ABOUT THE DECLINE IN THE PROPORTION OF U.S. CITIZENS PURSUING GRADUATE STUDIES IN SCIENCE AND ENGINEERING, AND THE SHORTAGE OF FACULTY IN CERTAIN AREAS OF SCIENCE AND ENGINEERING IN U.S. UNIVERSITIES.

THIS DECLINE LEADS NOT ONLY TO A POSSIBLE REDUCTION IN THE QUALITY OF INSTRUCTION AND RESEARCH, BUT ULTIMATELY, TO A POSSIBLE SHORTAGE OF PROFESSIONAL SKILLS REQUIRED BY INDUSTRY, GOVERNMENT, AND ACADEMIA.

EQUALLY IMPORTANT IS THE NEED TO UPGRADE AND MODERNIZE THE ACADEMIC RESEARCH ENVIRONMENT. MUCH OF THE EQUIPMENT AND INSTRUMENTATION IN UNIVERSITY RESEARCH LABORATORIES ARE NO LONGER THE BEST AVAILABLE. LABORATORY SPACE SHOULD BE ABLE TO ACCOMMODATE THE USE OF MORE COMPLEX PROCESSES AND EQUIPMENT OFTEN DEMANDED BY NEW AND EMERGING RESEARCH.

SCIENTIFIC RESEARCH REQUIRES LONG TERM CONTINUITY

WHILE THERE IS INCREASING RECOGNITION OF THE IMPORTANCE OF SCIENTIFIC ENDEAVORS, THE NEED FOR LONG-TERM STABILITY IS UNDERESTIMATED AND NOT EVERYONE REALIZES THAT THE INCUBATION PERIOD FOR SCIENCE AND ENGINEERING ENDEAVORS IS LONG. OVER THE LAST SEVERAL YEARS WE BELIEVE WE HAVE MADE THE VISIBLE COMMITMENT NECESSARY TO PRODUCE THE BEST RESEARCH AND GENERATE EXCEPTIONAL TALENT, AND WE WILL CONTINUE TO DO SO IN 1986.

2. NSF'S RESPONSIBILITY

THE NATIONAL SCIENCE FOUNDATION PURSUES ITS RESPONSIBILITY FOR THE HEALTH OF THE GENERAL SCIENTIFIC ENTERPRISE BY SUPPORTING THE MOST PROMISING FUNDAMENTAL, LONG-TERM RESEARCH BY THE BEST MINDS IN ALL FIELDS OF SCIENCE AND ENGINEERING.

THE PRINCIPAL PRODUCTS ARE TWOFOLD:

- NEW KNOWLEDGE AND DISCOVERIES AT THE CUTTING EDGE OF RESEARCH AND
- THE EDUCATION AND TRAINING OF THE WORLD'S MOST TALENTED AND CREATIVE SCIENTISTS AND ENGINEERS.

GAINING A NEW AND DEEPER UNDERSTANDING OF NATURE, AND REPLENISHING OUR SUPPLY OF SCIENTISTS AND ENGINEERS ARE ESSENTIAL IF WE ARE TO IMPROVE THE NATION'S INDUSTRIAL COMPETITIVENESS, DEFENSE, ECONOMY, AND HEALTH AND GENERAL WELL-BEING OF OUR CITIZENS.

OUR SUCCESS WILL DEPEND ON HOW WELL WE EDUCATE THE SCIENTISTS AND ENGINEERS OF TOMORROW AND HOW WELL WE PROVIDE FOR THE PURSUIT OF NEW KNOWLEDGE AND RESEARCH.

OUT OF A TOTAL OF NEARLY $8 BILLION OF BASIC RESEARCH FUNDED BY THE FEDERAL GOVERNMENT, THE NSF BUDGET REPRESENTS ONLY 17%. WHILE THE PERCENTAGE MAY SEEM SMALL OUR RESEARCH ROLE IS VERY IMPORTANT AND UNIQUE. WE ARE CONCERNED PRIMARILY WITH STRENGTHENING SCIENTIFIC RESEARCH POTENTIAL AND SCIENTIFIC EDUCATION PROGRAMS, AND NOT WITH SERVING AN END PRODUCT MISSION LIKE MOST OTHER AGENCIES ENGAGED IN RESEARCH SUPPORT.

3. NSF GOALS AND STRATEGIES

LET ME NOW TURN TO NSF GOALS AND STRATEGIES:

THE FIRST GOAL IS EXCELLENCE. IT HAS ALWAYS BEEN THAT WAY AND IT MUST CONTINUE. IN SCIENCE AND ENGINEERING RESEARCH, AS IN ANY CREATIVE ENDEAVOR, THE BEST IS VASTLY MORE VALUABLE THAN THE MERELY GOOD.

EXTERNALLY, IN OUR GRANTS AND CONTRACTS ACTIVITIES, EXCELLENCE MEANS MERIT-BASED PEER REVIEW. IT IS STILL THE BEST WAY TO ENSURE HIGH QUALITY AND BEST RETURN FOR THE NATION'S INVESTMENT.

INTERNALLY TO THE FOUNDATION, WE WILL CONCENTRATE ON EFFECTIVE AND EFFICIENT MANAGEMENT USING AUTOMATION WHERE POSSIBLE TO INCREASE OUR PRODUCTIVITY.

THE SECOND GOAL IS FOR NSF TO BE A CATALYST FOR CHANGE IN THE SCIENCE AND ENGINEERING COMMUNITY. THIS MEANS NOT ONLY PURSUING NEW RESEARCH OPPORTUNITIES, BUT ENCOURAGING NEW WAYS TO CARRY OUT RESEARCH.

- APPLYING INTERDISCIPLINARY APPROACHES TO NEW AND EMERGING RESEARCH POSSIBILITIES.
- DEVELOPING NEW RELATIONSHIPS BETWEEN GOVERNMENT AND PRIVATE INSTITUTIONS, AND BETWEEN INDUSTRY AND UNIVERSITIES.
- INCREASING COMMUNICATION AMONG RESEARCHERS IN ALL RESEARCH DISCIPLINES, AND STIMULATING THE SHARING OF EXPENSIVE EQUIPMENT, FACILITIES, AND KNOWLEDGE.

WHILE WE MAY ENCOURAGE SCIENCE AND ENGINEERING RESEARCH TO MOVE IN NEW DIRECTIONS IN A CONCERTED WAY, WE MUST AND WILL CONTINUE TO SUPPORT INDIVIDUAL RESEARCH PROJECTS DONE BY A PRINCIPAL INVESTIGATOR SCIENTIST AND A FEW STUDENTS. IT HAS PROVEN TO BE A SIMPLE YET MOST EFFECTIVE STRATEGY.

THE KEY IS TO BALANCE THIS WITH LARGE-SCALE COOPERATIVE EFFORTS. THERE IS AMPLE OPPORTUNITY AND NEED FOR BOTH; IT IS NOT ONE APPROACH OR THE OTHER.

THIRD, NSF MUST TRY TO IMPROVE THE HEALTH OF THE SCIENCE AND ENGINEERING INFRASTRUCTURE. INSTRUMENTATION, SPECIFIC FACILITIES INTEGRAL TO RESEARCH AND HUMAN RESOURCES SHOULD BE THE BEST TO REVITALIZE THE ACADEMIC RESEARCH BASE. WE WILL CONTINUE TO SUPPORT NEW AND ENHANCED INSTRUMENTATION AND ACCESS TO IT.

FOURTH, WE MUST CONTINUE TO HELP ATTRACT, EDUCATE, AND TRAIN STUDENTS FOR SCIENCE AND ENGINEERING. WE ARE DOING THIS THROUGH:

- FELLOWSHIPS OPEN TO ALL QUALIFIED APPLICANTS;
- SPECIAL PROGRAMS ADDRESSING MINORITIES, WOMEN, AND THE HANDICAPPED;
- PROGRAMS DESIGNED TO ATTRACT AND RETAIN FACULTY IN DISCIPLINES WHERE FACULTY SHORTAGES IMPEDE BASIC RESEARCH PROGRESS;
- PROGRAMS KEYED TO THE IMPROVEMENT OF PRECOLLEGE SCIENCE AND MATHEMATICS EDUCATION; AND
- INCREASED SUPPORT OF GRADUATE STUDENTS THROUGH RESEARCH PROJECTS.

FINALLY, WE WILL CONTINUE TO LEVERAGE GOVERNMENT FUNDS WITH PRIVATE SECTOR, STATE AND LOCAL GOVERNMENT, AND ACADEMIC SUPPORT IN ALL AREAS WHERE COOPERATION IS A POSSIBILITY AND IN THE BEST INTERESTS OF ALL PARTICIPANTS.

In order to move toward these goals and given the budget environment for FY 1986, the Foundation made decisions in order to maximize the funding available for academic science and engineering research activities. These include:

- Recognizing the need and the Administration's resolve to reduce NSF's administrative costs further. While NSF's administrative costs are already low compared to those of similar organizations, further efficiencies can be realized.

- Curtailing programs that are not in the mainstream of scientific and engineering research.

- Stretching out construction and acquisition of several major research projects including the VLBA.

- Making trade-offs with ongoing base programs in order to provide for enhancements in several key areas where research is essential to the Nation's pursuit of scientific and technological excellence and to training the next generation of scientists and engineers.

4. NSF Budget Request

I am pleased to tell you that the NSF's FY 1986 budget request continues the momentum established by this Administration, and supported by Congress, to keep U.S. science and engineering research the best in the world.

The Foundation's FY 1986 Budget Request totals $1,569.4 million or 4.4% above the FY 1985 Current Plan of $1,502.7 million. It includes:

- $1,397.8 million for Research and Related Activities, an increase of 7.4%.

- $120.1 MILLION FOR THE U.S. ANTARCTIC PROGRAM, UP 8.4%.

- $50.5 MILLION OF NEW OBLIGATIONAL AUTHORITY FOR SCIENCE AND ENGINEERING EDUCATION WHICH COMBINED WITH A PROPOSED DEFERRAL OF $31.5 MILLION FROM FY 1985 PROVIDES TOTAL RESOURCES OF $82.0 MILLION, THE SAME LEVEL AS 1985.

THIS BUDGET REQUEST, IF APPROVED BY CONGRESS:

- MAINTAINS SUPPORT AT CURRENT LEVELS FOR RESEARCH OF PROVEN QUALITY ACROSS ALL DISCIPLINES.

- INCREASES SUPPORT FOR RESEARCH RELATED TO U.S. ECONOMIC COMPETITIVENESS SUCH AS ENGINEERING RESEARCH CENTERS, BIOTECHNOLOGY.

- INCREASES PROGRAMS THAT PROVIDE ESSENTIAL BASIC SUPPORT FOR ADVANCES IN SCIENCE AND TECHNOLOGY, FOCUSING IN ADDITION TO THE RESEARCH, ON INSTRUMENTATION AND SPECIFIC FACILITIES THAT ARE AN INTEGRAL PART OF THE PROPOSED RESEARCH. SOME ACTIVITIES, HOWEVER, SUCH AS THE CONSTRUCTION OF THE VERY LONG BASELINE ARRAY WILL CONTINUE BUT AT A SOMEWHAT SLOWER PACE THAN ORIGINALLY PLANNED DUE TO BUDGET CONSTRAINTS.

- FOCUSES PRESIDENTIAL YOUNG INVESTIGATOR AWARDS ON YOUNGER FACULTY THAN IN PREVIOUS YEARS AND PROVIDES AN ADDITIONAL $6.0 MILLION TO SUPPORT 100 NEW AWARDS IN 1986 BRINGING THE TOTAL TO 500.

THESE ARE SOME OF THE HIGHLIGHTS OF OUR 1986 REQUEST. I EXPECT TO DISCUSS THE BUDGET IN GREATER DETAIL AT THE UPCOMING AUTHORIZATION HEARING. HOWEVER, THERE ARE SEVERAL AREAS THAT I WOULD LIKE TO TALK ABOUT TODAY.

BIOTECHNOLOGY

BIOTECHNOLOGY

WHILE THE U.S. IS CURRENTLY THE WORLD LEADER IN MOST ASPECTS OF BIOTECHNOLOGY, WE CANNOT TAKE THAT LEADERSHIP ROLE FOR GRANTED. THE BASIS FOR OUR LEADERSHIP IS VERY FRAGILE, AND WE MUST CONTINUE TO WORK HARD TO MAINTAIN IT THROUGH FEDERAL, INDUSTRIAL, AND ACADEMIC EFFORTS, INDIVIDUALLY AND IN PARTNERSHIP.

NIH, USDA, DOE, AND DOD SUPPORT BIOTECHNOLOGY RESEARCH RELATED TO PROBLEM-ORIENTED APPLICATIONS. NSF, HOWEVER, HAS A UNIQUE ROLE TO PLAY IN EXPANDING FUNDAMENTAL KNOWLEDGE, ENCOURAGING NEW MULTIDISCIPLINARY RESEARCH OPPORTUNITIES AND, IMPORTANTLY, PRODUCING THE NECESSARY TALENT IN BIOTECHNOLOGY. ALSO WE HAVE EXPERIENCE IN DEALING WITH THE MULTIDISCIPLINARY APPROACH THAT IS NECESSARY FOR RAPID PROGRESS IN BIOTECHNOLOGY RESEARCH, AND ESSENTIAL FOR TRAINING OUR BEST STUDENTS IN BIOLOGY, CHEMISTRY, AND PLANT SCIENCE.

NSF IS ALSO THE PRIMARY FEDERAL SUPPORTER OF BASIC RESEARCH IN SYSTEMATICS AND ECOLOGY. THIS RESEARCH FORMS THE SCIENTIFIC BASE NECESSARY TO ASSESS THE POTENTIAL ENVIRONMENTAL IMPACT OF THE VARIOUS PRODUCTS AND BYPRODUCTS OF BIOTECHNOLOGY.

EDUCATION AND TRAINING

OUR LEADERSHIP ROLE IN SCIENCE AND ENGINEERING RESEARCH DEPENDS ON STIMULATING AND MAINTAINING AN ADEQUATE SUPPLY OF TALENTED YOUNG STUDENTS AND GRADUATES.

NSF PLAYS A LIMITED BUT CATALYTIC ROLE AT ALL EDUCATIONAL LEVELS THROUGH:

- DIRECT SCIENCE AND ENGINEERING EDUCATION PROGRAMS.
- RESEARCH GRANTS WHICH NOT ONLY ENHANCE EDUCATION BUT ALSO PERMIT TRAINING WITH SENIOR RESEARCHERS AND SOPHISTICATED INSTRUMENTS.

At the precollege level, we are placing a special emphasis on science and mathematics programs at the elementary and middle school levels to provide leadership in the training of teachers, the development of sound instructional materials, and the appropriate use of modern technology.

At the undergraduate level, we support a number of students participating in research grants, help with instructional equipment needs at the Nation's four-year colleges, and fund faculty research projects at predominantly undergraduate institutions. We cannot overlook these four-year institutions, because many leading scientists and engineers receive their basic training at predominantly undergraduate schools.

Support for graduate students and postdoctorals come in large part from their participation in NSF-supported research grants. In 1985 the number of graduate students and postdocs supported in research grants is expected to increase 4% to a total of 14,387. We also will provide support for over 1500 Graduate Research Fellowships.

Finally, we provide, with matching funds and participation from the industrial sector, the Presidential Young Investigator Research Awards. These awards encourage promising young scientists and engineers to select and remain in academic careers.

International

The Foundation's international research activities are becoming increasingly important to the overall success of our science and engineering research efforts. International participation:

o Encourages cooperation and communication.

o Provides access to special facilities, instruments and expertise located abroad.

- ALLOWS ACCESS TO SITES TO OBSERVE NATURAL AND SOCIAL PHENOMENA.
- ENCOURAGES COST SHARING OF LARGE RESEARCH INSTALLATIONS.
- SERVES TO SUPPORT AND STRENGTHEN U.S. FOREIGN POLICY OBJECTIVES.

NSF TOGETHER WITH THE DEPARTMENT OF STATE HAS FORMAL BILATERAL AGREEMENTS FOR COOPERATIVE RESEARCH WITH SOME 30 COUNTRIES, CUTTING ACROSS A WIDE RANGE OF DISCIPLINES. WE ALSO PROVIDE SUPPORT TO THE NATIONAL ACADEMY OF SCIENCES FOR COOPERATION WITH SISTER ACADEMIES IN CHINA AND EASTERN EUROPE, AND PARTICIPATE IN SUCH ADMINISTRATION INITIATIVES AS THE U.S. - INDIA SCIENCE AND TECHNOLOGY AGREEMENT.

FOR THE MOST PART, HOWEVER, THERE ARE MORE INFORMAL, DISCIPLINE-ORIENTED INTERNATIONAL RESEARCH ACTIVITIES. TWO MAJOR INTERNATIONAL COOPERATIVE ACTIVITIES -- ANTARCTIC RESEARCH AND OCEAN DRILLING -- TOGETHER WITH SOME 700 OTHER PROJECTS PROVIDE $73.0 MILLION FOR RESEARCH BY U.S. SCIENTISTS IN COLLABORATION WITH SCIENTISTS IN OTHER COUNTRIES.

IT IS IMPORTANT FOR BOTH SCIENCE AND ENGINEERING RESEARCH AND U.S. FOREIGN POLICY OBJECTIVES THAT WE MAINTAIN STRONG INTERNATIONAL RESEARCH ACTIVITIES. IN FY 1986, WE PROPOSE TO CHANGE THE BALANCE SLIGHTLY BETWEEN THE FORMAL AND INFORMAL DISCIPLINARY RESEARCH ACTIVITIES, AND OVERALL TO INCREASE OUR INTERNATIONAL RESEARCH SUPPORT.

COMPUTERS

COMPUTERS PLAY A CENTRAL AND CRITICAL ROLE IN SCIENCE AND ENGINEERING RESEARCH. AS RESEARCH TOOLS, THEY PROVIDE NEW OPPORTUNITIES TO EXPLORE, OBSERVE, AND UNDERSTAND PHENOMENA. IN THIS WAY, COMPUTERS BROADEN THE BASE OF SCIENCE AND ENGINEERING KNOWLEDGE.

AS A DISCIPLINE, RESEARCH IN COMPUTATIONAL MATHEMATICS, SYSTEMS AND DESIGN, INFORMATION SCIENCE, AND OTHER AREAS HELPS EXPAND THE KNOWLEDGE BASE FROM WHICH STATE-OF-THE-ART COMPUTER TECHNOLOGY SPRINGS.

THERE ARE FOUR MAJOR COMPONENTS TO OUR COMPUTING ACTIVITIES:

- SUPERCOMPUTER FACILITIES WILL MAKE AVAILABLE TO THE RESEARCH COMMUNITY THE MOST ADVANCED COMPUTING EQUIPMENT. IT SHOULD ALSO STIMULATE THE CONTINUING INVOLVEMENT OF U.S. INDUSTRY IN THIS IMPORTANT FIELD.
- NETWORKING WILL LINK SCIENTISTS AND ENGINEERS, ENCOURAGING COLLABORATION, RESOURCE SHARING AND RAPID DISSEMINATION OF RESEARCH RESULTS.
- LOCAL FACILITIES PROVIDE HELP WITH THE ACQUISITION AND OPERATION OF ESSENTIAL COMPUTING FACILITIES OR SERVICES NEEDED ON A DAILY BASIS TO CARRY OUT RESEARCH.
- RESEARCH ON COMPUTERS PROVIDES SUPPORT TO ADVANCE THE STATE-OF-THE-ART IN COMPUTER TECHNOLOGY.

THERE ARE SEVERAL AGENCIES -- DOD, DOE, NASA, AND NIH THAT PROVIDE SIMILAR SUPPORT TO SCIENTISTS AND ENGINEERS WORKING ON MISSION-SPECIFIC PROJECTS RELEVANT TO THOSE AGENCIES.

THE NSF, HOWEVER, HAS A UNIQUE -- AND QUITE ESSENTIAL -- ROLE BECAUSE IT DOES NOT IMPOSE MISSION CRITERIA IN SELECTION OF THE RESEARCH PROJECTS. MORE IMPORTANTLY, NSF CAN PROVIDE SUPPORT FOR COMPUTER RESEARCH AND COMPUTERS ACROSS A WIDE SPECTRUM OF DISCIPLINES.

THIS HAS VERY IMPORTANT CONSEQUENCES.

FIRST, IT PROVIDES KNOWLEDGE AND TALENT THAT MIGHT NOT OTHERWISE BE AVAILABLE. NSF SUPPORTED MUCH OF THE EARLY CONCEPTUAL WORK IN HIGHLY PARALLEL COMPUTER ARCHITECTURES YEARS BEFORE THE RELEVANCE OF THAT WORK TO DEFENSE, ENERGY, AND OTHER MISSIONS WAS RECOGNIZED.

IN ADDITION, TRAINING OF GRADUATE STUDENTS IN COMPUTER RESEARCH AND ENGINEERING IS ACCOMPLISHED THROUGH NSF-SUPPORTED FACILITIES. THESE FACILITIES ARE USED EXTENSIVELY BY GRADUATE STUDENTS TO CONDUCT RESEARCH IN MANY DISCIPLINES, RESEARCH WHICH IS OFTEN NSF-SUPPORTED.

CONCLUSION

MR. CHAIRMAN, IN CONCLUSION, I WANT TO STRESS THAT WE ARE INDEED FORTUNATE TO BE AT A MAJOR TRANSITION POINT, BECAUSE WITH TRANSITION COMES OPPORTUNITIES. THE RESEARCH ENVIRONMENT IS IN TRANSITION, AND WITH IT THE OPPORTUNITY TO PUSH BACK THE FRONTIERS OF SCIENCE AND ENGINEERING. PUBLIC ATTITUDES TOWARD SCIENCE ARE CHANGING, TOO. THERE IS A GROWING CONSCIOUSNESS THAT BASIC RESEARCH IS AN ESSENTIAL INGREDIENT FOR CONTINUED ECONOMIC HEALTH, NATIONAL SECURITY, AND QUALITY OF LIFE.

WE MUST CAPITALIZE ON THESE OPPORTUNITIES. THIS BUDGET REQUEST ALONG WITH YOUR CONTINUED SUPPORT SIGNALS A STRONG COMMITMENT TO KEEP U.S. SCIENTIFIC AND ENGINEERING RESEARCH AND TECHNOLOGY THE WORLD'S BEST.

THAT CONCLUDES MY TESTIMONY. I WILL BE GLAD TO ANSWER ANY QUESTIONS YOU HAVE.

National Science Foundation
Washington, D.C. 20550

FY 1986

Budget Summary

New Obligational Authority	
FY 1986 Budget Request	$1,569,399,722
FY 1985 Appropriation (P.L. 98-371)	1,501,792,000
Proposed Recission	-2,002,000
Proposed Deferral	-31,450,278
Proposed Supplemental Appropriation Request	750,000
FY 1985 New Obligational Authority	1,469,089,722
Increase in New Obligational Authority FY 1986 FY 1985	100,310,000
Program Level	
FY 1986:	
Appropriation	$1,569,399,722
Plus FY 1986 Deferral	31,450,278
FY 1986 Program Level	1,600,850,000
FY 1985:	
Appropriation	$1,501,792,000
Less Proposed Recission	-2,002,000
Less Proposed Deferral	-31,450,278
Plus Carryover	33,609,280
Plus Proposed Supplemental Appropriation Request	750,000
FY 1985 Program Level	1,502,699,002
Increase in Program Level FY 1986/1985	$98,150,998

NATIONAL SCIENCE FOUNDATION
FY 1986 BUDGET SUMMARY

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National Science Foundation

SUMMARY OF FY 1986 BUDGET BY APPROPRIATION AND PROGRAM

	Actual FY 1984	*Request FY 1985*	*Current Plan FY 1985*	*Estimate FY 1986*	*Difference FY 1986/85*
RESEARCH AND RELATED ACTIVITIES APPROPRIATION					
Mathematical and Physical Sciences	$355,046,031	$416,710,000	$396,622,000	$428,970,000	$32,348,000
Engineering	128,614,515	147,100,000	150,037,000	170,070,000	20,033,000
Biological, Behavioral and Social Sciences	223,401,248	253,120,000	251,967,000	272,050,000	20,083,000
Astronomical, Atmospheric, Earth and Ocean Sciences	328,635,030	373,480,000	351,728,249	372,170,000	20,441,751
Scientific, Technological and International Affairs	36,211,146	46,900,000	44,460,000	38,360,000	-6,100,000
Advanced Scientific Computing	6,009,400	—0—	41,460,000	46,230,000	4,770,000
Program Development and Management	66,256,632	70,902,000	70,689,000	69,900,000	-789,000
Subtotal, Obligations	1,144,174,004	1,308,212,000	1,306,963,249	1,397,750,000	90,786,751
Funding Reconciliation					
Unobligated Balance Available, Start of Year	-704,680	—0—	-2,053,249	—0—	2,053,249
Proposed Recission	—0—	—0—	2,002,000	—0—	-2,002,000
Appropriation Transfer	—0—	—0—	-5,000,000	—0—	5,000,000
Unobligated Balance Available, End of Year	2,053,249	—0—	—0—	—0—	—0—
Adjustments to Prior Year Accounts	-3,563,893	—0—	—0—	—0—	—0—
Unobligated Balance Lapsing	301,320	—0—	—0—	—0—	—0—
Research and Related Activities Appropriation	1,142,260,000	1,308,212,000	1,301,912,000	1,397,750,000	95,838,000
U.S. ANTARCTIC PROGRAM ACTIVITIES					
U.S. Antarctic Research Program	10,432,804	11,000,000	11,000,000	11,500,000	500,000
Operations Support	91,954,900	104,080,000	99,898,296	108,600,000	8,701,704
Subtotal, Obligations	102,387,704	115,080,000	110,898,296	120,100,000	9,201,704
Funding Reconciliation					
Unobligated Balance Available, Start of Year	—0—	—0—	-68,296	—0—	68,296
Unobligated Balance Available, End of Year	68,296	—0—	—0—	—0—	—0—
U.S. Antarctic Program Activities Appropriation	102,456,000	115,080,000	110,830,000	120,100,000	9,270,000
SCIENCE AND ENGINEERING EDUCATION ACTIVITIES APPROPRIATION					
Research Career Development	20,311,329	21,000,000	27,300,000	27,300,000	—0—
College Science Instrumentation	—0—	—0—	5,000,000	5,000,000	—0—
Material Development and Research	23,432,567	27,700,000	22,700,000	22,700,000	—0—
Teacher Enhancement and Informal Science Education	11,890,402	25,000,000	25,000,000	25,000,000	—0—
Studies and Program Assessment	1,809,084	2,000,000	2,000,000	2,000,000	—0—
Subtotal, Obligations	57,443,382	75,700,000	82,000,000	82,000,000	—0—
Funding Reconciliation					
Unobligated Balance Available, Start of Year	-13,913,430	—0—	-31,450,278	-31,450,278	-31,450,278
Appropriation Transfer	—0—	—0—	5,000,000	—0—	-5,000,000
Unobligated Balance Available, End of Year	31,450,278	—0—	31,450,278	—0—	—0—
Adjustments to Prior Year Accounts	-59,887	—0—	—0—	—0—	—0—
Unobligated Balance Lapsing	79,657	—0—	—0—	—0—	—0—
Science and Engineering Education Activities Appropriation	75,000,000	75,700,000	87,000,000	50,549,722	-36,450,278
SPECIAL FOREIGN CURRENCY APPROPRIATION					
Special Foreign Currency	2,910,776	2,800,000	2,837,457	1,000,000	-1,837,457
Subtotal, Obligations	2,910,776	2,800,000	2,837,457	1,000,000	-1,837,457
Funding Reconciliation					
Unobligated Balance Available, Start of Year	-13,680	—0—	-37,457	—0—	37,457
Unobligated Balance Available, End of Year	37,457	—0—	—0—	—0—	—0—
Adjustments to Prior Year Accounts	-79,453	—0—	—0—	—0—	—0—
Unobligated Balance Lapsing	44,900	—0—	—0—	—0—	—0—
Special Foreign Currency Appropriation	2,900,000	2,800,000	2,800,000	1,000,000	-1,800,000
TOTAL, NSF APPROPRIATIONS	**$1,322,616,000**	**$1,501,792,000**	**$1,502,542,000**	**$1,569,399,722**	**$66,857,722**

NSF FY 1986 BUDGET REQUEST

The National Science Foundation's FY 1986 Budget requests new obligational authority of $1,569.4 million and proposes a deferral of $31.5 million from FY 1985 into FY 1986. The total $1,600.9 million, is $98.2 million above the FY 1985 Current Plan of $1,502.7 million. It includes $1,397.8 million for Research and Related Activities of which $69.9 million is for Program Development and Management; $120.1 million for the U.S. Antarctic Program; $82.0 million for Science and Engineering Education and $1.0 million for Special Foreign Currency.

This Budget Request maintains support at current levels for research of proven quality across all disciplines; increases support for some specific programs and projects of particular current importance, and offsets these increases by reductions in, or termination of, programs of lower priority.

Specifically, this Budget Request:

o Increases support for research related to long term U.S. economic competitiveness.

Support for Engineering Research Centers increases by $15.0 million above the FY 1985 level of $10.0 million. In FY 1985, NSF expects to start 5 to 10 such centers and a similar number in FY 1986. Research related to the emerging and economically important field of Biotechnology increases by $9.3 million above the FY 1985 level of approximately $70.0 million. Research on the Continental Lithosphere increases by $4.4 million above the FY 1985 level of $7.0 million. Other increases include Research on Advanced Materials ($3.2 million) and Engineering Design studies ($1.4 million).

o Increases support for programs that are key to the basic infrastructure of academic research.

Access to Advanced Scientific Computing is increased by $4.8 million above the FY 1985 level of $41.5 million. This increase, together with other adjustments, will allow the establishment of an additional National Center in FY 1986, bringing the total to four. Support for equipment and instrumentation is increased by $32.7 million above the FY 1985 base of $217.8 million exclusive of facilities. The proposed budget levels for Advanced Scientific Computing, Biotechnology, and Engineering Research Centers, include support for facilities where these are an integral part of the proposed program.

- Provides for leadership opportunities through quality programs in Science and Engineering Education.

  The program remains at the FY 1985 appropriation level of $82.0 million. The request proposes $50.5 million in new obligational authority and $31.5 million to be carried forward from FY 1985. The Foundation's Science and Engineering Education program is in a period of rebuilding and evaluation. This funding level, which is $24.6 million above FY 1984, will support the highest quality projects and allow the Foundation to build opportunities for strong future leverage. Together with the training component of other NSF research programs the Science and Engineering Education activity forms a major educational component of U.S. science and engineering.

- Enhances programs where NSF has major or unique responsibilities.

  These increases include support for mathematics (a $7.2 million increase above the FY 1985 level of $47.5 million) and Social and Economic Sciences (a $5.4 million increase above the FY 1985 level of $33.9 million).

- Continues major enhancements of research capabilities at a reduced rate due to budget constraints.

  These include the construction of the Very Long Baseline Array radio telescope ($11.5 million in FY 1986), the acquisition of an advanced computing system for the National Center for Atmospheric Research (NCAR) ($5.0 million in FY 1986), and capital improvements ($12.0 million in FY 1986) to the Cornell Electron Storage Ring.

- Offsets increases by combining related programs for greater efficiency and reducing or terminating support for lower priority programs.

  These reductions total $34.0 million distributed as follows: Mathematical and Physical Sciences--$6.3 million; Engineering--$8.0 million; Biological, Behavioral and Social Sciences--$6.6 million; Astronomical, Atmospheric, Earth and Ocean Sciences--$6.1 million; Scientific, Technologial and International Affairs--$7.0 million. Examples of programs that will be terminated include Alternate Biological Resources ($2.5 million in FY 1985), Ethics and Values in Science and Technology ($1.0 million), Productivity Improvement Research ($1.0 million) and Intergovernmental Science and Technology ($0.5 million). Other reductions involve decreasing or phasing out lower priority projects.

- Continues Presidential Young Investigator awards.

  The program will focus on younger faculty than in previous years (those less than four years beyond the Ph.D.). An additional $6.0 million will support one hundred new awards in FY 1986. This brings the total number of young investigators being supported to five hundred. The support is for five years and requires industrial sharing above a level of $25,000 per year. The maximum award is $100,000 per year.

- Reduces Program Development and Management.

  The request proposes $69.9 million, a reduction of $0.8 million from FY 1985. This is based on the Foundation's resolve to maximize support for research and education and to reduce internal administrative costs in line with the Administration's plan to reduce operating expenses including a 5 percent pay cut. This will support 1,174 FTE's, 20 fewer than authorized in FY 1985.

Several organizational changes are proposed to ensure optimum use of Foundation resources and to increase the effectiveness of programs. Specifically:

- The Engineering activity is reorganized to enable the Foundation to take greater advantage of the engineering research capabilities of universities, to strengthen the links between universities and industry, and to focus on emerging and critical problems in engineering research. In addition, the Industry/University Cooperative Research Projects and Centers programs ($10.0 million) are transferred from the Scientific, Technological and International Affairs activity to Engineering.

- To enhance coupling to core research programs, support in FY 1986 for Minority Research Initiation (MRI) ($2.5 million), Research Opportunities for Women (ROW) ($1.0 million), and the Experimental Program to Stimulate Competitive Research (EPSCOR) ($2.0 million) is distributed to disciplinary activities. The FY 1986 support for Research Opportunities for Women and the Experimental Program to Stimulate Competitive Research is double the FY 1985 level. The responsibility for management and coordination of these programs will remain with STIA.

- Support for international cooperative research specifically related to bilateral agreements ($9.7 million) is consolidated in STIA. Close coordination between STIA and the disciplinary activities will continue for both the management of these programs and the development of other international programs supported by the disciplinary activities.

STRATEGY FOR FY 1986

In formulating program and budget priorities for FY 1986, several important considerations guided the Foundation's allocations. Within the available resources, high priority is given to:

- Educating and attracting scientists and engineers necessary for the Nation's future science and technology base through:

  - Fellowships open to all disciplines.
  - Special programs addressing the underrepresentation of minorities, women, and the physically handicapped in science and engineering.
  - Programs that encourage young faculty in disciplines where faculty shortages are severe.
  - Programs addressing precollege science and mathematics education.
  - Support of graduate students through research projects in all fields of science and engineering.

o Continuing the emphasis on research instrumentation through programs to replace worn-out or obsolete instrumentation, to acquire sophisticated new instruments necessary to pursue experimental research in many forefront areas, and, in special cases, to provide support for new or modified laboratory space. This is an essential element in the Foundation's efforts to revitalize the academic research base.

o Maintaining an appropriate balance of support between research fields and among large projects, coordinated research activities, and individual investigator projects.

o Leveraging federal funds with private sector, state, and academic funds in all areas where cooperation is a possibility and in the best interest of all participants.

There is increasing recognition of the importance of science and engineering research to the future of the Nation, that research activities are long term investments and that continuity over an extended period of time is very important. Given the constrained budget environment for FY 1986, the Foundation must make difficult choices in order to minimize the impact on academic science and engineering research activities. These include:

o Reducing NSF's administrative costs further. They are already low compared to those of similar organizations.

o Curtailing programs that are not in the mainstream of science and engineering research and education.

o Enhancing, but at a slower rate than originally planned, several major activities started in earlier years (Engineering Research Centers, Access to Advanced Scientific Computing, and Research on the Continental Lithosphere).

- Stretching out construction and acquisition of several major research projects including the Very Long Baseline Array (VLBA) radio telescope.

- Making trade-offs with ongoing base programs in order to provide for enhancements in several key areas where research is essential to the Nation's pursuit of scientific and technological advances, and, importantly, to training the next generation of scientists and engineers.

HIGHLIGHTS OF THE NSF FY 1986 REQUEST BY ACTIVITY

MATHEMATICAL AND PHYSICAL SCIENCES (MPS)

The FY 1986 Budget Request for MPS is $429.0 million. This represents an increase of $32.4 million, or 8.2 percent, over the FY 1985 Current Plan. Mathematical Sciences increases by $7.2 million to $54.7 million, Computer Research increases by $2.6 million to $41.7 million; Physics increases by $7.8 million to $123.4 million; Chemistry increases by $6.1 million to $93.5 million; and Materials Research increases by $8.6 million to $115.7 million.

These increases affect the major components of all programs as follows:

Research Project Support -- Support for scientific research projects (SRPS) is increased by $24.2 million, or 8.2 percent, to a total of $288.7 million. Included in that amount is instrumentation totalling $35.6 million.

- In Mathematical Sciences, continued improvement is made in the support of graduate students and young investigators on research project awards in accordance with the recommendations of the 1984 report from the National Research Council entitled, Renewing U.S. Mathematics: Critical Resource for the Future.

- In Computer Research, emphasis will be given to project support, particularly in theoretical areas. Project support has been held nearly constant for several years while experimental computer science capabilities were built up through the Coordinated Experimental Research program.

- In Physics, ensuring adequate support for the best research projects in the various subfields reduces the number of senior investigators supported. Included are university-based user groups in elementary particle physics and nuclear sciences, as well as other SRPS projects in atomic, molecular, and plasma physics, theory, and gravitational physics. An amount of $1.0 million is included to continue planning studies for a full-scale laser interferometer for gravitational wave detection.

- In Chemistry, increased support is provided for innovative projects that result from the research thrusts in materials chemistry and the chemistry of life processes, both initiated in FY 1985. In other areas, support for high priority programs is maintained by the selective termination of research projects that are less competitive. The number of senior investigators supported remains at approximately 975 in order to maintain average grant size at the FY 1985 level.

- In Materials Research, enhanced support is provided for the collaborative group research program, interdisciplinary research on materials chemistry, and research on novel materials. In other areas, support for high priority projects is maintained by reducing support for lower priority activities. The number of senior investigators supported is decreased somewhat to provide necessary support for instrumentation, materials and supplies, and graduate students and postdoctoral researchers.

Special Equipment Programs -- Mathematical Sciences, Computer Research, Chemistry, and Materials Research provide support through formal or informal programs for the acquisition of research instrumentation and equipment intermediate in cost between that normally provided in research project awards and that available at major laboratories and national user facilities. This type of instrumentation is generally for group or departmental use and represents an effective way of sharing experimental capabilities. Support for special equipment programs is increased by $1.8 million, or 9.3 percent, to a total of $21.2 million.

University Laboratories -- Support for research, operations, and instrumentation at university laboratories in Computer Research, Physics, and Materials Research is increased by $1.7 million, or 2.8 percent, to a total of $63.5 million. Within this total, the amount included for instrumentation is $21.7 million. Included are the experimental computer research facilities, the electron accelerator at the University of Illinois, a number of nuclear physics laboratories, the Joint Institute for Laboratory Astrophysics at the University of Colorado, and the Materials Research Laboratories.

National User Facilities -- Support for national user facilities is increased by $4.7 million, or 9.2 percent, to a total of $55.6 million. Within this total, the amount included for instrumentation is $22.7 million. These facilities include the Mathematical Sciences and the Theoretical Physics Institutes, the Cornell Electron Storage Ring, the Indiana University Cyclotron Facility, the Michigan State University Superconducting Cyclotron, the Synchrotron Radiation Facilities at Cornell University and the University of Wisconsin, the Center for High-Resolution Electron Miscroscopy at Arizona State University, the Small Angle Scattering Facility, and the National Magnet Laboratory.

The MPS total for all categories of research equipment is increased by $11.4 million, or 15.1 percent, to a total of $102.1 million. This represents an increase in the fraction of the total budget devoted to research instrumentation and equipment from 22.3 percent to 23.8 percent.

ENGINEERING (ENG)

The President's Science Advisor, the Congress, the National Academy of Engineering, and the National Science Foundation and Board have been increasingly concerned about the need to maintain industrial competitiveness and to strengthen engineering research and education in the United States at a time when engineering is undergoing fundamental changes.

As part of its mission to ensure the health of research and education in science and engineering, the National Science Foundation intends to give the United States important added research capacity to maintain its leadership in engineering over the long term via a strategy that includes: a reorganization of the Engineering Directorate to address engineering research and education goals more effectively; developing closer links between universities and industry needs over the long term through Engineering Research Centers and Industry/University Cooperative Research Projects and Centers; and a budget request for FY 1986 that includes increases for emerging fields of engineering research. This request is coupled with an effort to leverage the activity by requiring industry participation and support.

The FY 1986 Budget Request for Engineering is $170.1 million. This represents an increase of $20.0 million, or 13.3 percent, over the FY 1985 Current Plan of $150.1 million. Support is included for an additional 50 Presidential Young Investigators in engineering bringing the total to 250. Having achieved this level of support for young engineers, the Foundation is proposing to terminate the Research Initiation Grant Programs. The FY 1986 Request provides balanced support for established and emerging fields of engineering research, including further development of Engineering Research Centers, as follows:

Research Project Support in Established Fields of Engineering -- Support for research projects in established major fields of Engineering is increased by $1.9 million, or 2.5 percent to a total of $79.7 million. Specifically:

- Chemical, Biochemical and Thermal Engineering remains at the FY 1985 level of $29.4 million. Support is increased in several research areas including kinetics and catalysis, separation and purification processes, and thermodynamics and transport phenomena. Activities will be curtailed in nucleonics, energy conversion, and non-solid multiphase flow.
- Mechanics, Structures and Materials Engineering is increased by $0.6 million to a total of $23.7 million. Support is increased in several research areas including solid mechanics, fluid dynamics and hydraulics, tribology, dynamical systems and control, and materials engineering and processing. Activities will be curtailed in selected areas of geotechnical engineering and structural mechanics.
- Electrical, Communications and Systems Engineering is increased by $1.3 million to a total of $26.7 million. Support is increased in several areas including solid state and microstructures, systems theory and operations research, and instrumentation, sensing and measurement. Activities will be curtailed in theoretical

electromagnetics, two-dimensional imaging, and one-dimensional digital signal processing.

Research Project Support in Emerging Fields of Engineering -- Support for research projects in important emerging areas such as design methodology and systems integration, automation, manufacturing systems, and emerging technologies such as biotechnology is increased by $6.6 million or 12.6 percent to a total of $58.9 million. Specifically:

- Design, Manufacturing and Computer Engineering is increased by $3.2 million to a total of $20.4 million. Research areas receiving increased support include computer-integrated design and manufacturing, computer research and design theory and methodology applicable to all fields of engineering.

- Emerging and Critical Engineering Systems is increased by $3.4 million to a total of $38.5 million. Research areas receiving increased support include biotechnology, bioengineering and research to aid the handicapped, lightwave technology; environmental engineering, systems engineering for large structures, and natural and man-made hazard mitigation. Societal response research in the Earthquake Hazard Mitigation program will be curtailed.

Cross-Disciplinary Research -- Support for Engineering Research Centers and Industry/University Cooperative Centers and Projects is increased by $11.5 million or 57.6 percent to a total of $31.5 million:

- Engineering Research Centers is increased by $15.0 million to a total of $25.0 million. The program continues to emphasize experimental capabilities not available to individual investigators; opportunities for cross-disciplinary teams to focus on areas of research such as engineering systems in manufacturing, materials processing, and communications; training students to synthesize, integrate, and manage engineering systems; interaction between industry and universities.

- Industry/University Cooperative Research Centers remains at the FY 1985 level of $3.0 million and continues to foster university/industry interactions by supporting basic and applied research at university centers in fields of industrially relevant science and technology. In contrast to the Engineering Research Centers, where the emphasis is on a strong education effort associated with a research program that has a long-term commitment of NSF support, the purpose of this program is to initiate centers that can obtain sufficient industry, state, and other public sector support to become self sustaining after the initial grant period.

- Industry/University Cooperative Research Projects is reduced by $3.5 million from the FY 1985 level of $7.0 million to $3.5 million. Approximately the same number of projects will be supported in FY 1986 as were in FY 1985 and the total support from this program and other disciplinary activities will remain at the FY 1985 level of $14.0 million. The portion of the total funds provided by this program will be reduced from 50 to 25 percent.

BIOLOGICAL, BEHAVIORAL, AND SOCIAL SCIENCES (BBS)

The FY 1986 Budget Request for BBS of $272.1 million is an increase of $20.1 million, or 8.0 percent over the FY 1985 Current Plan. The request will permit continued progress towards the goals of increasing knowledge about life forms and life and social processes through research on biological and social phenomena. Part of the increase will be used to strengthen support for promising areas of fundamental research related to biotechnology. Within the activity:

- Molecular Biosciences is increased by $3.2 million to a total of $64.1 million. Areas of emphasis will be molecular plant biology, multidisciplinary projects in chemistry and biology of life processes, and research using innovative genetic approaches and acquisition of large equipment for shared use by investigators. Research in biophysics, biochemistry, prokaryotic genetics, and metabolic biology will continue to characterize much of the subactivity.

- Cellular Biosciences is increased by $3.5 million to a total of $54.4 million. The increase will permit continued emphasis in plant biology, the use of genetic and immunological techniques as research tools, and support of research instrumentation. Support will be provided for interdisciplinary research by biologists and chemists, and for retraining scientists in contemporary research technologies. The research disciplines encompassed by the proposed funding are cell biology, cellular physiology, developmental biology, eukaryotic genetics, and regulatory biology.

- Biotic Systems and Resources is increased by $4.6 million to a total of $63.0 million. The increase will be used to support young investigators for research in plant biology and for refurbishing field laboratories, including terrestrial laboratories. Research in the ecological sciences and in systematic and population biology will continue to analyze ecological relationships, factors affecting biological productivity, and processes basic to the development of biological diversity.

- Behavioral and Neural Sciences is increased by $2.8 million to a total of $47.1 million, with most of the growth in neurosciences, where powerful new techniques permit progress in understanding nervous system development. Cognitive science will maintain its emphasis on the learning process, and anthropology will continue to stress research into human origins and development of artifact dating techniques.

- Social and Economic Science is increased by $5.4 million to a total of $33.9 million. Support will increase for economic research including research of the type previously supported under the auspices of other Federal activities, for current data base development, methodological research, and for instrumentation for the analysis of large scale data bases. Basic research initiatives in social measurement and analysis and in governance and decision processes will be maintained.

- Information Science and Technology is increased by $0.6 million from $8.9 million to $9.5 million. The program will increase support levels in information technology and information impact. Emphasis remains on improving understanding about the way information is structured, represented, manipulated and used, on improving the interaction of human users and information processing systems, and on understanding the effects of information and information technologies on economic and social processes.

ASTRONOMICAL, ATMOSPHERIC, EARTH, AND OCEAN SCIENCES (AAEO)

The FY 1986 Budget Request for AAEO is $372.2 million, an increase of $20.4 million or 5.8 percent over the FY 1985 Current Plan of $351.7 million. The changes in individual subactivities are as follows:

- Astronomical Sciences is increased by $5.6 million to a total of $88.7 million. This increase will be targeted on highest priority activities recommended in the report of the Astronomy Survey Committee of the National Academy of Sciences. Included is continuing support for the acquisition of the Very Long Baseline Array (VLBA) radio telescope, a project singled out by the report as being of high priority.

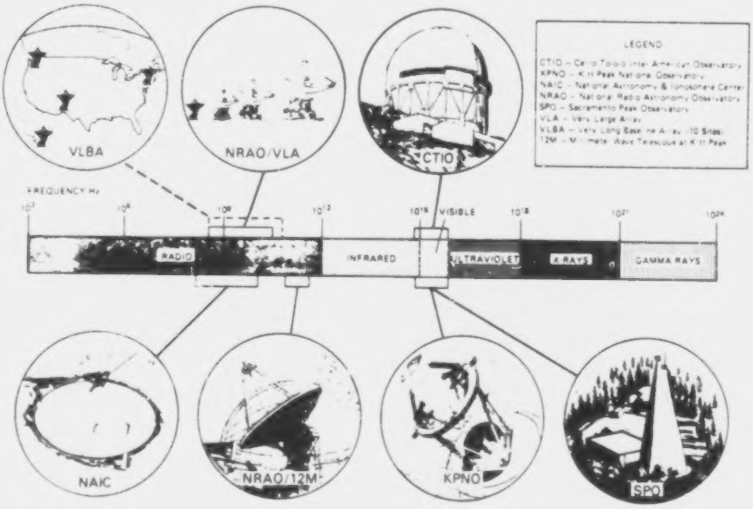
- Atmospheric Sciences is increased by $3.4 million to a total of $97.6 million. The major increase will be for instrumentation and research equipment acquisition and increased research costs. Funding to continue the acquisition of an advanced computer system at the National Center for Atmospheric Research will be the same as planned for FY 1985, $5.0 million. The Global Atmospheric Research Program, now well into the data analysis phase, continues to phase down.

- Earth Sciences is increased by $5.6 million to a total of $51.5 million, which allows for increased continental reflection profiling operations, major upgrading of instrumentation, and a major research thrust on the chemistry, structure, and geologic history of the continental lithosphere. The continental lithosphere thrust will include continuation of site surveys for possible future deep continental drilling, development of seismograph arrays to map the structure of the earth's crust and underlying mantle, use of the satellite global positioning system to make precise geodetic measurements, and studies of the physics and chemistry of geological materials to aid in interpretations of geophysical data.

- Ocean Sciences is increased by $4.9 million to a total of $125.6 million, with emphasis on global ocean studies. Increased instrumentation support will be provided through project grants. Maintenance and upgrading of shipboard scientific equipment also are priorities. The Ocean Drilling Program will be fully operational.

- Arctic Research is increased by $0.9 million to a total of $8.8 million, which offsets inflationary increases in project support and provides funding for the Arctic Research Commission and the Interagency Arctic Research Policy Committee.

SPECTRUM COVERAGE OF TELESCOPES AT NATIONAL ASTRONOMY CENTERS


VLBA
NRAO/VLA
CTIO
LEGEND
CTIO – Cerro Tololo Inter American Observatory
KPNO – Kitt Peak National Observatory
NAIC – National Astronomy & Ionosphere Center
NRAO – National Radio Astronomy Observatory
SPO – Sacramento Peak Observatory
VLA – Very Large Array
VLBA – Very Long Baseline Array (10 Sites)
12M – Millimeter Wave Telescope at Kitt Peak
FREQUENCY Hz
10^3
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ULTRAVIOLET
X-RAYS
GAMMA RAYS
NAIC
NRAO/12M
KPNO
SPO

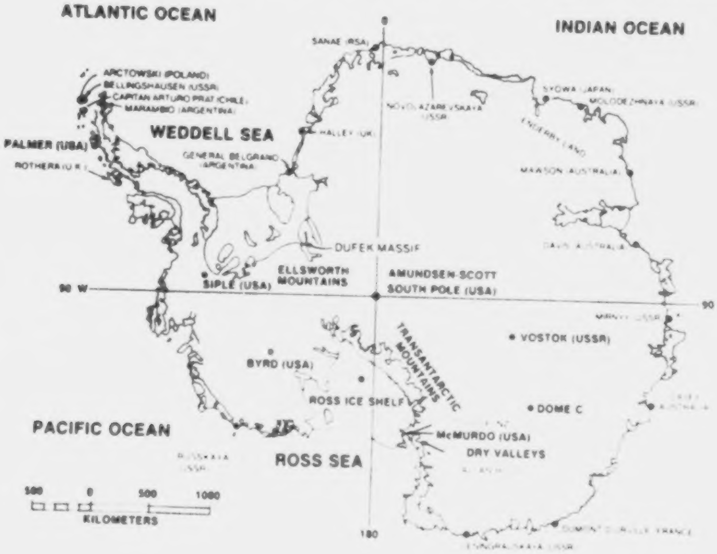
U.S. ANTARCTIC PROGRAM (USAP)

The FY 1986 Budget Request for USAP increases 8.3 percent over the FY 1985 Current Plan. The increase of $9.2 million from $110.9 million to $120.1 million is required for the following expenses:

- The major amount, \$5.0 million, is for the continuation of major maintenance and upgrading of two older LC-130 aircraft. This aircraft rework, which was formerly called Service Life Extension Program or SLEP, is now underway using funds approved in FY 1984.

- The remaining \$4.2 million will be used to offset a general increase in costs and the charter of a specially equipped ship of the Academic Fleet to conduct a marine seismic survey in the southern oceans. The increased ship charter costs are about \$0.8 million, leaving \$2.9 million for other operations cost increases and \$0.5 million for research grant cost increases.

ANTARCTICA: selected stations and physical features.


ATLANTIC OCEAN
INDIAN OCEAN
SANAE (RSA)
ARCTOWSKI (POLAND)
BELLINGSHAUSEN (USSR)
CAPITAN ARTURO PRAT (CHILE)
MARAMBIO (ARGENTINA)
NOVOLAZAREVSKAYA (USSR)
SYOWA (JAPAN)
MOLODEZHNAYA (USSR)
WEDDELL SEA
HALLEY (UK)
ENDERBY LAND
PALMER (USA)
ROTHERA (U.K.)
GENERAL BELGRANO (ARGENTINA)
MAWSON (AUSTRALIA)
DAVIS (AUSTRALIA)
DUFEK MASSIF
ELLSWORTH MOUNTAINS
SIPLE (USA)
AMUNDSEN-SCOTT SOUTH POLE (USA)
90 W
90 E
MIRNYY (USSR)
VOSTOK (USSR)
TRANSANTARCTIC MOUNTAINS
BYRD (USA)
ROSS ICE SHELF
DOME C
PACIFIC OCEAN
McMURDO (USA)
DRY VALLEYS
ROSS SEA
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DUMONT D'URVILLE (FRANCE)
LENINGRADSKAYA (USSR)
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KILOMETERS

ADVANCED SCIENTIFIC COMPUTING (ASC)

The FY 1986 Budget Request for ASC increases by \$4.8 million, or 11.5 percent to a total of \$46.2 million in FY 1986.

- One additional National Center for advanced scientific computing will be supported in FY 1986 to supplement the National Centers initiated in FY 1985. Plans for FY 1985 include three National Centers using proven supercomputer systems and an additional center using an experimental system. Also, supercomputer time will continue to be purchased as necessary from the Interim Centers, which have provided supercomputer time in FY 1984 and FY 1985.

- Work to improve networks necessary to provide ready access to the centers will continue as will software improvement. Funding from this activity for local equipment needs will be reduced, as funds for such equipment are increased in the disciplinary programs. Scientific use of experimental computing systems not commercially available will be emphasized.

SCIENTIFIC, TECHNOLOGICAL, AND INTERNATIONAL AFFAIRS (STIA)

The Scientific, Technological, and International Affairs activity carries out essential Foundation responsibilities that cut across scientific disciplines. The FY 1986 Budget Request of $38.4 million is a net decrease of $6.1 million or 13.8 percent less than the FY 1985 Current Plan of $44.5 million. Several programs have been transferred to the disciplinary activities to improve their effectiveness and future impact. These transfers include the incorporation of the Industry/University Cooperative Research Projects and Centers program elements in the Engineering activity and the inclusion of the funding for Research Opportunities for Women, the Minority Research Initiation, and the Experimental Program to Stimulate Competitive Research program elements in discipline-oriented research activities of the Foundation.

Several other programs of lower priority in a period of constrained budgets -- Productivity Improvement Research, Ethics and Values in Science and Technology, and Intergovernmental Science and Technology -- will be terminated. Researchers formerly supported through these programs will be able to compete for support in other NSF programs, for example in Social and Economic Science. Within STIA:

- Industrial Science and Technological Innovation (ISTI) decreases from $13.4 million to $13.3 million. The Small Business Innovation Research (SBIR) program element is increased by $0.9 million (from $12.4 million to $13.3 million) and maintains a total program equal to one percent of the Foundation's research budget. The program will continue to support high quality research proposals from science- and high-technology-based small business firms on important scientific and engineering problems and opportunities that could lead to significant public benefit if the research is successful.

- International Cooperative Scientific Activities decreases from $13.6 million in FY 1985 to $12.1 million. This amount will provide support for U.S. participation in cooperative research projects, seminars, workshops, and short-term scientific visits abroad, at a level slightly less than in FY 1985. About 1,300 U.S. scientists, 100 fewer than in FY 1985, are expected to participate in these joint activities. It will allow for continued coordination and management of NSF's responsibilities under bilateral agreements.

This subactivity will continue to support cooperative projects under the Indo-U.S. Science and Technology Initiative at a level of $1.7 million, $300,000 less than FY 1985. Special emphasis will be maintained in FY 1986 on programs in China, Eastern Europe, Western Europe, Sub-Saharan Africa, and Latin America as well as continuation of U.S. participation in international scientific organizations.

- Policy Research and Analysis decreases by $2.7 million to a total of $2.0 million in FY 1986. In a period of constrained budgets, this effort will focus on only the highest priority activities, such as S&T policy related questions raised by the National Science Foundation and other Executive agencies.

- Science Resources Studies decreases by $0.3 million to a total of $4.0 million in FY 1986. This level is sufficient to maintain the existing science resources data base and continue the ongoing programs of regular periodic surveys. Support will continue for recently initiated efforts to develop more current and accurate indicators of S&T resources and activities in selected major industrial countries.

- Research Initiation and Improvement decreases by $1.5 million to a total of $7.0 million in FY 1986. Program elements to be funded entirely by discipline-oriented research activities will increase by a net amount of $3.5 million over the $48.4 million level provided in FY 1985. The increase will go to: Support for Predominantly Undergraduate Institutions -- $2.0 million (from $42.4 million to $44.4 million); Research Opportunities for Women -- $0.5 million (from $0.5 million to $1.0 million); Experimental Program to Stimulate Competitive Research -- $1.0 million (from $1.0 million to $2.0 million). Other programs in this subactivity -- Visiting Professorships for Women and Research Improvement in Minority Institutions will remain at essentially their FY 1985 level.

SCIENCE AND ENGINEERING EDUCATION (SEE)

The FY 1986 program total for SEE is $82.0 million. This total includes an FY 1986 Request for new obligational authority of $50.5 million and deferral of $31.5 million from FY 1985. The FY 1986 Program total remains the same as the FY 1985 appropriation of $82.0 million. The FY 1985 deferral of $31.5 million is the same as the amount carried over from FY 1984 into FY 1985.

The problems facing the Nation's schools are well known, due in large part to the publicity given to numerous national commission reports that have appeared in the last few years. Many activities directed at solving these problems are now underway throughout the country. Despite increased efforts at the state and local levels and increased private sector support, there remains a need for national-level leadership activities carefully structured to provide support at minimal but critical levels to catalyze a range of improvement efforts.

Although SEE has a responsibility and concern for all levels of science and engineering education, the program is currently targeting for special emphasis the science and mathematics taught in the middle and elementary grades of the Nation's schools.

There is a need for communication networks among the activities now underway and those to be developed. NSF's programs have been designed to satisfy these needs, capitalizing on its unique position to lead this effort. This unique position is derived from NSF's extensive interactions with practicing scientists and engineers and with educational and professional institutions and societies.

NSF will continue to support graduate fellowships in the sciences and engineering, significant improvements at the high school level, and limited, but high-leverage, activities at the undergraduate level.

In FY 1986, support will be provided for:

- Research Career Development ($27.3 million). The activity funds NSF Graduate Research Fellowships to recognize and support the Nation's most talented graduate students and prepare them to enter the science and engineering work force, with specific attention given to the participation of minorities.
- College Science Instrumentation ($5.0 million). This program supports efforts to strengthen the laboratories and curricula in undergraduate science instruction at the Nation's four-year colleges.
- Materials Development and Research ($22.7 million). This program supports projects to enable scientists and science educators to develop instructional materials for students and for teacher training, to better understand the processes of teaching and learning, and to study and develop future applications of advanced technologies.
- Teacher Enhancement and Informal Science Education ($25.0 million). This effort supports local and regional projects for continuing education and professional development for precollege mathematics and science teachers, programs of informal science education through museums and the media, and dissemination activities to bring teachers information on new programs and materials.

- o Studies and Program Assessment ($2.0 million). Through this program the Foundation will institute studies and analyses to provide a systematic and current understanding of the condition of science and mathematics education in the United States.

The building of partnerships and communication networks is a central element in NSF's Science and Engineering Education plan for FY 1986 and the future. This and other aspects of the program are consistent with the goals and purposes of P.L. 98-377, the Education for Economic Security Act.

PROGRAM DEVELOPMENT AND MANAGEMENT (PD&M)

The PD&M estimate of $69.9 million is a net reduction of $0.8 million from the FY 1985 Current Plan. If, as in previous years, the FY 1986 estimate level had included funding for the full impact of anticipated inflation, full annualization of the Federal pay increase effective January 1985, announced postage rate increases, and expected telephone rate increases, the minimum requirement would be about $73.5 million. The $69.9 million estimate is based on NSF's resolution to maximize support for research and education and to minimize administrative costs. This reflects administration policies to reduce operating expenses, including a reduction of 20 FTEs, and a proposal to reduce all salary levels by five percent, effective January 1, 1986.

The estimate provides funding for 1,174 authorized full-time equivalent employment. Travel funds are held at about the FY 1985 level, while certain other costs categories have been increased to lease more efficient telephone equipment, which will have the longer-term effect of reducing communication costs, and purchase ADP equipment to achieve efficiencies in management and administrative operations. Funds are also included to continue space rennovations to conform with current General Services Administration space utilization regulations and thereby reduce future rental costs.

HIGHLIGHTS OF MULTI-ACTIVITY PROGRAMS

1. SCIENCE AND ENGINEERING TRAINING AND EDUCATION

Education at all levels in the United States is fundamentally a widely dispersed enterprise, conducted mostly through the efforts of locally autonomous schools, colleges, and universities. Funding from the National Science Foundation represents only a small fraction of the total national support for science and engineering education. Nevertheless, NSF funding is designed to gain maximum leverage and serve as a catalyst for achieving improvements and for strengthening the Nation's base of high quality scientific and engineering personnel.

NSF activities capitalize on the links of NSF to the academic community and stress the appropriate participation of highly qualified scientists and engineers. Emphasis is placed on team efforts that include scientists, engineers, educators, active teachers, and where appropriate, officials of state and local educational agencies, and the private sector.

It is vitally important that the Nation continue to invest in the maintenance of a strong base of science and engineering education. Such an investment will be a significant factor in:

- o Stimulating and improving the Nation's economic growth and productivity;
- o Providing a well-trained human resource pool essential to future technological breakthroughs of benefit to society;
- o Maintaining U.S. leadership in science and technology and improving the Nation's competitive position in international trade; and
- o Strengthening U.S. national security.

The Foundation's FY 1986 Budget Request assists in addressing the needs in science and engineering education and in the training of young scientists and engineers. Responsibilities for these efforts involve both the Foundation's Science and Engineering Education activity and its disciplinary research activities.

At the Precollege Level

The Foundation's Science and Engineering Education (SEE) activity will place special emphasis on the science and mathematics programs in the Nation's elementary and junior high schools. Strong evidence suggests that not only are these educational levels crucial to the ultimate outcomes of education, but that the problems involved in learning and motivation in mathematics and science are the most complex at these levels. At the same time, support will continue for promising programs at the high school level.

The FY 1986 program is designed to assist in providing the highest quality precollege science and mathematics education activities for America's youth. These activities will enable scientists and educators to develop new or improved instructional materials for students and teachers; provide for research and development on the application of advanced technologies, particularly the computer, to the teaching and learning of science and mathematics; support local and regional programs of continuing education and professional development for teachers; and provide for annual recognition of outstanding secondary school teachers through the Presidential Awards for Excellence in Science and Mathematics Teaching.

The program will support informal science education activities to improve understanding and awareness of science using a variety of media, including radio, television, and museums. Activities designed to publicize and disseminate information about highly successful programs and outstanding research in science and engineering education will be supported.

Program funds will also provide for studies and analyses of existing data bases to provide a systematic and current understanding of the condition of precollege science and mathematics education in the United States.

At the Undergraduate Level

Research awards to doctoral granting institutions will provide opportunities for about 3,000 undergraduate research participants. The Engineering Research Centers program will also provide important opportunities for the training of undergraduate engineering students.

The College Science Instrumentation program will provide matching funds of $5.0 million for the acquisition of modern instrumentation at the Nation's 4-year colleges to improve their capabilities in science and engineering instruction. In addition, support for faculty research at predominantly undergraduate institutions (institutions awarding 20 or fewer Ph.D.'s in science and engineering over the past two years) is estimated to increase from $42.4 million in FY 1985 to $44.4 million in FY 1986 or by 4.7 percent. This amount comprises support for research proposals submitted directly to disciplinary research programs; proposals submitted through the Research in Undergraduate Institutions (RUI) program, which increases from $7.6 million in FY 1985 to $8.0 million in FY 1986; and for Research Opportunity Awards (ROA), that provide for faculty at small colleges to participate in research projects at large institutions. Support under these activities will provide for a stronger coupling between research and education in the Nation's predominantly undergraduate institutions. It will provide greater opportunities for faculty and students at these institutions to gain hands-on experience with the latest scientific instrumentation and research techniques.

At the Graduate Level

Support for graduate students on research awards increases from $102.1 million in FY 1985 to $110.9 million in FY 1986 or by 8.6 percent. This will provide support for an additional 445 graduate students bringing the total to about 11,140. These graduate research assistants are selected by faculty principal investigators and carry out significant research tasks while at the same time gaining valuable learning experiences that help prepare them for future careers in science and engineering. The Engineering Research Centers, in particular, will help train graduate students to gain better understanding of modern engineering practice.

Support for NSF Graduate Research Fellowships is continued at the FY 1985 level of $27.3 million. The recipients of NSF graduate fellowships are highly talented U.S. citizens who are selected through a national competition on the basis of merit. In FY 1986, the Foundation will make 560 new fellowship awards, bringing the total number of graduate fellows supported to approximately 1,500. The stipend remains at the FY 1985 level of $11,100 per year, and the yearly cost-of-education allowance remains at $6,000.

SUPPORT OF GRADUATE STUDENTS ON RESEARCH PROJECTS

(Dollars in Millions)

	Number Supported				*Amount of Support*			
	Actual FY 1984	*Estimate FY 1985*	*Estimate FY 1986*	*% Diff. FY 86/85*	*Actual FY 1984*	*Estimate FY 1985*	*Estimate FY 1986*	*% Diff FY 86/85*
Research & Related Activities								
Mathematical & Physical Sciences	4,354	4,587	4,753	3.6%	$37.3	$42.1	$45.8	8.8
Engineering	1,902	2,127	2,325	3.5	22.7	25.8	28.6	10.9
Biological, Behavioral & Social Sciences	1,830	1,985	2,054	3.5	13.3	15.1	16.0	6.0
Astronomical, Atmospheric, Earth & Ocean Sciences	1,657	1,685	1,735	3.0	16.5	16.4	17.8	8.5
Scientific, Technological, & International Affairs	139	152	90	-40.8	1.0	1.3	0.9	-30.8
Advanced Scientific Computing	0	60	100	66.7	0.0	0.7	1.2	71.4
U.S. Antarctic Program	69	73	76	4.1	0.6	0.6	0.6	0.0
Special Foreign Currency	30	29	10	-65.5	0.1	0.1	.03	-70.0
TOTAL, NSF	**9,981**	**10,698**	**11,143**	**4.2%**	**$91.5**	**$102.1**	**$110.93**	**8.6%**

At the Postdoctoral Level

Support for postdoctoral researchers increases from $57.1 million in FY 1985 to $61.2 million in FY 1986 or by 7.2 percent. The number of postdoctorals supported increases from 3,132 to 3,253 or by 3.9 percent.

SUPPORT OF POSTDOCTORALS ON RESEARCH PROJECTS

Dollars in Millions

	Number Supported				*Amount of Support*			
	Actual FY 1984	*Estimate FY 1985*	*Estimate FY 1986*	*% Diff FY 86-85*	*Actual FY 1984*	*Estimate FY 1985*	*Estimate FY 1986*	*% Diff FY 86-85*
Research & Related Activities:								
Mathematical & Physical Sciences	1,443	1,523	1,581	3.8	$27.10	$30.10	$32.40	[illegible]
Engineering	201	227	269	18.5	2.50	2.90	3.40	17.2
Biological, Behavioral & Social Sciences	807	858	871	1.5	13.70	15.10	16.00	6.0
Astronomical, Atmospheric, Earth & Ocean Sciences	420	452	465	2.9	7.10	7.80	[illegible]	6.3
Scientific, Technological & International Affairs	41	46	40	-13.0	0.59	0.73	[illegible]	[illegible]
Advanced Scientific Computing	0	8	8	0.0	0.00	0.20	0.25	[illegible]
U.S. Antarctic Program	17	18	19	5.6	0.21	0.23	0.24	[illegible]
TOTAL, NSF	**2,929**	**3,132**	**3,253**	**3.9%**	**$51.20**	**$57.06**	**$61.22**	**7.3%**

Presidential Young Investigators

The Presidential Young Investigators Research Awards, initiated in FY 1984, provide research support for the Nation's most promising young science and engineering faculty members. The awards, which generally combine Foundation and industrial support, are intended to encourage promising young scientists and engineers, those within four years of the Ph.D., to select and remain in academic careers. This will help ensure the excellence of the Nation's science and engineering education, training, and research.

In FY 1986, NSF will support 500 Presidential Young Investigator awards, including 100 new awards and 400 ongoing awards initiated in FY 1984 and FY 1985, at a level of $29.8 million. About half of the new awards will be made to young engineering faculty, where there is an identified continuing shortage.

2. INTERNATIONAL SCIENCE AND ENGINEERING

The main purpose of the Foundation's international activities is to strengthen the U.S. research effort in science and engineering. The immediate benefits of the activities to the United States result from sharing the costs of large research installations; access to special facilities, instruments, environments, and expertise located abroad; access to foreign research materials and to sites for observing natural and social phenomena; and sharing of effort upon and immediate benefits from regional and global research on the environment. Moreover, cooperative science and engineering programs often serve to support and strengthen U.S. foreign policy objectives. The success of U.S. scientific and engineering research and the maintenance of the Nation's well-being have become increasingly dependent on international cooperation.

One Foundation grant out of every five contains some form of international implication. Activities supported may range from travel by U.S. scientists to attend scientific meetings held abroad, through research projects conducted abroad, to taking part in major global programs in specific disciplines, for example, in the atmospheric and ocean sciences.

The Scientific, Technological and International Affairs activity manages most of NSF's formal international cooperative research through programs with some 30 countries for bilateral cooperation across a wide range of disciplines. STIA also manages NSF participation in such Administration initiatives as the Indo-U.S. Science and Technology Initiative. It provides support to the National Academy of Sciences for cooperation with sister academies in China and Eastern Europe, and support for U.S. participation in the International Council of Scientific Unions. STIA also manages the Special Foreign Currency Budget Activity.

However, STIA directly manages only a portion of the Foundation's total international activities as is evident from the table below. The discipline-oriented research activities provide support for two major international cooperative activities, Antarctic Research and Ocean Drilling, and in the normal activity of supporting scientific research projects, fund about 700 projects for approximately $80.0 million that have some form of international implication. In addition, the discipline-oriented research activities actively participate in the review and oversight of projects supported by the STIA Activity. An interdirectorate steering group meets regularly to provide a forum for policy and management issues affecting international science and engineering activities in all parts of the Foundation. The discipline-oriented activities are instrumental in establishing the research agendas of the bilateral agreements.

The following table shows NSF support for international activities in terms of cooperative research carried out under formal bilateral or multilateral agreements; research projects that are intrinsically international; and special activities, including support for international institutions, that are sufficiently large to be identified individually.

NSF SUPPORT OF INTERNATIONAL SCIENCE ACTIVITIES
Millions of Dollars

	Actual FY 1984	Current Plan FY1985	Estimate FY 1986	Difference FY 1986/85
Cooperative Research				
STIA	$ 9.8	$ 10.5	$ 9.7	$ -0.8
International Related Research Projects				
Disciplinary Activities	73.5	76.9	81.5	4.6
Special Activities				
Antarctic Research	22.5	24.8	26.8	2.0
Ocean Drilling	26.3	27.6	28.9	1.3
International Science Organizations	1.1	1.1	0.7	-0.4
Indo-U.S. Initiative	2.0	2.0	1.7	-0.3
Special Foreign Currency	2.9	2.8	1.0	-1.8
TOTAL	$138.1	$145.7	$150.3	$ 4.6

3. EQUIPMENT AND INSTRUMENTATION

The National Science Foundation provides support for equipment and instrumentation to meet the needs of experimental research in four major ways:

- Through the provision of instrumentation to individual projects and investigators;
- Through the provision of multiuser equipment at the department level;
- Through the support of university-based centers and facilities such as the Materials Research Laboratories, which permit coordinated multi-disciplinary thrusts and require a diversity of scientific and engineering competence; and
- Through the funding of national centers, such as those for the Astronomical Sciences, that provide major facilities serving hundreds of scientists.

Between FY 1983 and FY 1985, NSF support for facilities, equipment, and instrumentation at universities and centers increased from $120 million to $239 million or by about 99 percent. This trend is continued in the FY 1986 Budget Request with an increase of $32.7 million above the FY 1985 level planned for high priority equipment and instrumentation, including the support of local computing equipment. Support for land, buildings, and fixed equipment is reduced and the total increase for Facilities, Equipment, and Instrumentation is $31.1 million, 13.0 percent above the FY 1985 level.

Support in FY 1986 for construction or acquisition of major facilities started in FY 1985 include the Very Long Base Array (VLBA) radio telescope, the acquisition of an advanced computer for the National Center for Atmospheric Research, and the planning and development of centers for advanced scientific computing.

R&D FACILITIES, EQUIPMENT, AND INSTRUMENTATION
(Millions of Dollars)

	Actual FY 1984	Estimate FY 1985	Estimate FY 1986	Increase (Percent)	
				FY 86/84	FY 86/85
Mathematical and Physical Sciences	$74.8	$88.7	$102.1	36.5%	15.1%
Engineering	17.6	21.7	25.9	47.2	19.4
Biological, Behavioral, and Social Sciences	22.2	26.7	31.6	42.3	18.4
Astronomical, Atmospheric, Earth and Ocean Sciences	48.8	50.7	53.3	9.2	5.1
U.S. Antarctic Program	22.2	20.9	26.0	17.1	24.4
Scientific, Technological and International Affairs	2.2	3.1	3.1	40.9	—0—
Advanced Scientific Computing	—0—	22.2	23.1	—	4.1
Science and Engineering Education	0.9	5.7	5.7	533.3	13.0
TOTAL, NSF	**$188.7**	**$239.7**	**$270.8**	**43.5%**	**13.0%**

4. COMPUTERS AND COMPUTER SCIENCE AND ENGINEERING

Computers play a central role in every discipline of science and engineering. The goals of the National Science Foundation in computer activities are to make advanced computer technology available for research and education and to support research which provides the basis for future advances in computer technology. The Foundation accomplishes these goals through three types of activities:

- Providing supercomputer facilities for use in research, developing a national science network to improve access to and sharing of facilities and software;

- Assisting with the purchase and operation of local computing facilities such as workstations, mini-computers, graphics equipment, and array processors; and

- Supporting research in computer science and in other areas that advance the state of computer technology. NSF support for research in computer science and engineering is provided through several programs, and involves work in computer and information science, computer engineering, computational mathematics and electronic materials.

A matter of particular importance to NSF is the training of advanced graduate students in computer science and engineering and applications. The facilities that receive NSF support are used extensively by graduate students to conduct the research which is the capstone of their graduate training and often performed in NSF-supported research projects. The NSF-sponsored research projects in computer science and engineering are the main source of support for graduate students in that field, providing stipends and research costs to several hundred students each year.

In FY 1986, support for computer related activities increases by 11.4 percent from $200.8 million in FY 1985 to a total of $223.7 million as follows.

- Supercomputer Facilities provides support for establishing and operating supercomputer centers for use in science and engineering research and training. Support increases from $32.5 million to $38.7 million. Support for supercomputer activities at NCAR remains at $12.0 million.

- Networking provides support for establishing and operating networks to provide easy access from the normal working location of scientists and engineers to remote computing facilities. It also provides advanced communication services to the scientific community to promote collaboration and resource sharing and rapid dissemination of research results. Support increases from $5.0 million to $5.5 million.

- Local Facilities provides help with the acquisition and operation of essential computing facilities at the researcher's office or laboratory and includes workstations, mini-computers, graphics facilities, local area networks, array processors, and other computing facilities or services needed on a daily basis to carry out research. Support increases from $79.1 million to $90.0 million.

- Research on Computers provides support for research in computational mathematics, computer systems and design, information science, materials research, and other areas that help advance the state-of-the-art in computer technology. Support increases from $72.0 million to $77.50 million.

Several other federal agencies, especially the Department of Defense, the Department of Energy, the National Aeronautics and Space Administration, and the National Institutes of Health also provide computer support for scientists and engineers who are working on projects relevant to those agencies. NSF is unique because it does not impose criteria of specific mission relevance on the selection of the projects it supports. This has very important consequences as highlighted in the Research Briefing on Computer Architecture report prepared for the Committee on Science, Engineering and Public Policy of the National Academy of Sciences in the summer of 1984. That report showed NSF to have been the source of support for much of the early conceptual work in highly parallel computer architectures years before the relevance of that work to defense, energy, and industry was recognized. Many of the ideas and people supported by NSF have subsequently been taken up by the mission agencies and are being supported by them further to develop those concepts into working prototype machines so their effectiveness can be evaluated in the context of mission specific problems. The Strategic Computer Programs of Defense Advanced Research Project Agency and the computer research support program of Department of Energy are cases in point.

5. RESEARCH RELATED TO BIOTECHNOLOGY

NSF proposes to strengthen its biotechnology-related research during the coming fiscal year by providing an increase at $9.3 million or 13.3 percent over the FY 1985 level at approximately $70.0 million. Historically, NSF provided a large portion of the long term basic research support in the biological and biochemical sciences that led to the biological revolution and the development of modern biotechnology. Currently, NSF supports a wide variety of research activities such as fundamental genetics of bacteria and higher organisms, cell culture biology, nucleic acid chemistry and plant cell molecular biology. These biotechnology related activities involve research encompassing both science and engineering. The findings from the current work form the underpinnings of future progress and the base upon which biotechnology efforts will be built. NSF is also the primary supporter of research in ecology and systematics which forms the scientific foundation for answering questions about the impact of genetically engineered organisms on natural systems. The realization of the promise of biotechnology for the economic and health interests of the Nation is dependent on a broad base of fundamental research findings. NSF is well positioned to continue to build this scientific base through support of multidisciplinary research in science and engineering. NSF will direct the additional funding to selected target areas within chemistry, biology and engineering, including:

- Plant cell protoplast culture, cell fusion and the biochemistry of plant cell regeneration. Research in these areas is critical to the development of plant cell biotechnology both for the generation of new food and fiber crops and for the utilization of plant products in medicine and industry.

- Identification and production of physiologically active peptides such as neuropeptides and hormones as well as plant cell products which impart natural resistance to insects and disease.

- Design and development of bioreactors including modern approaches to fermentation technology and methods of product recovery.

- Training of personnel, especially the cross training between molecular biology and chemical and manufacturing engineering, molecular biology and plant biology and molecular biology and ecology.

This increased effort is intended to lead to new applications in areas of significance to the nation, such as agriculture and medicine, and to new uses of biotechnology as a key research tool for science.

Explanation of Prior Year Carryover

In addition to the FY 1985 appropriations, unobligated balances totaling $33,609,280 are available for obligation in FY 1985. The source of these funds are:

- No-Year Funds - Prior to FY 1974, NSF appropriations were made on a no-year basis and unobligated funds were available until expended. As a result of the deobligation in FY 1984 of obligations made in previous year, there is a balance of $87,414 available for obligation in FY 1985.

  As part of the Second Supplemental Appropriation Act of 1984 (PL 98-396), the Foundation was appropriated $1,500,000 for the Advanced Scientific Computing program. Since the Act was passed August 22, 1984, there was not sufficient time prior to September 30, 1984 for obligating these funds and they, therefore, have been carried over into FY 1985.

- The unobligated balance of the FY 1984 Research and Related Activities Appropriation is $465,835 and results from relatively minor balances in over 300 individual operating plan accounts. Of this amount $370,000 will be used in FY 1985 to partially fund the costs of the January 1985 pay increase for which the Foundation will absorb the full costs, the balance, $95,835, along with the unobligated no-year funds will be used to support the requirements of the Arctic Research and Policy Act.

- Science and Engineering Education Activities - $31,450,278 of unobligated FY 1984 appropriation remains available for obligation in FY 1985. Because of the expansion of these activities, the time required to develop specific programs and the time required for soliciting and reviewing proposals, the awards made in FY 1984 did not require all funds available. These unobligated funds will be used in FY 1985 for the planned FY 1984 activities.

- Special Foreign Currency - A total of $37,457 of unobligated FY 1984 funds will be utilized in the FY 1985 program.

- U.S. Antarctic Program - A total of $68,296 remained unobligated at the end of FY 1984 and will be available for use in the program during FY 1985.

BUDGET SUMMARY OF OBLIGATIONS BY ACTIVITY AND SUBACTIVITY SHOWING DOLLAR AND PERCENTAGE CHANGES, FY 1986/FY 1985

(**Millions of Dollars**)

Activity & Subactivity	Actual FY 1984	Current Plan FY 1985	Estimate FY 1986	Difference FY 1986/FY 1985	
				Amount	Percent
RESEARCH & RELATED ACTIVITIES					
Mathematical and Physical Sciences					
Mathematical Sciences	$41.3	$47.5	$54.7	$7.2	15.1
Computer Research	33.7	39.1	41.7	2.6	6.6
Physics	104.4	115.5	123.4	7.9	6.8
Chemistry	79.4	87.4	93.5	6.1	6.9
Materials Research	96.3	107.1	115.7	8.6	8.0
Subtotal, MPS	355.1	396.6	429.0	32.4	8.1
Engineering					
Chemical, Biochemical, and Thermal Engineering	28.7	29.4	29.4	—0—	—0—
Mechanics, Structures, and Materials Engineering	22.7	23.0	23.6	0.6	2.6
Electrical, Communications, and Systems Engineering	23.7	25.4	26.7	1.3	5.1
Design, Manufacturing, and Computer Engineering	10.8	17.1	20.4	3.3	19.2
Emerging and Critical Engineering Systems	32.7	35.1	38.5	3.4	9.6
Cross-Disciplinary Research	10.0	20.0	31.5	11.5	57.5
Subtotal, Engineering	128.6	150.0	170.1	20.1	13.4
Biological, Behavioral, and Social Sciences					
Molecular Biosciences	54.2	60.9	64.1	3.2	5.2
Cellular Biosciences	47.3	50.9	54.4	3.5	6.8
Biotic Systems and Resources	52.9	58.4	63.0	4.6	7.8
Behavioral and Neural Sciences	38.2	44.4	47.1	2.7	6.0
Social & Economic Sciences	24.6	28.5	33.9	5.4	18.9
Information Science and Technology	6.2	8.9	9.5	0.6	6.7
Subtotal, BBS	223.4	252.0	272.0	20.0	7.9
Astronomical, Atmospheric, Earth and Ocean Sciences					
Astronomical Sciences	77.3	83.0	88.7	5.7	6.8
Atmospheric Sciences	88.4	94.2	97.6	3.4	3.6
Earth Sciences	41.4	45.9	51.5	5.6	12.2
Ocean Sciences	114.2	120.7	125.6	4.9	4.0
Arctic Research Program	7.3	7.9	8.8	0.9	11.3
Subtotal, AAEO	328.6	351.7	372.2	20.5	5.8
Scientific, Technological, and International Affairs					
Industrial Science and Technological Innovation	8.1	13.4	13.3	-0.1	-.8
International Cooperative Scientific Activities	12.9	13.6	12.1	-1.5	-11.1
Policy Research & Analysis	4.6	4.7	2.0	-2.7	-57.5
Science Resources Studies	4.2	4.3	4.0	-0.3	-7.0
Research Initiation and Improvement	6.4	8.5	7.0	-1.5	-17.7
Subtotal, STIA	36.2	44.5	38.4	-6.1	-13.8
Advanced Scientific Computing	6.0	41.5	46.2	4.7	11.3
Program Development and Management	66.3	70.7	69.9	-0.8	-1.2
Total, Research and Related Activities	1,144.2	1,307.0	1,397.8	90.8	6.9
U.S. ANTARCTIC PROGRAM					
U.S. Antarctic Research Program	10.4	11.0	11.5	0.5	4.5
Operations Support	92.0	99.9	108.6	8.7	8.7
Total, U.S. Antarctic Program	102.4	110.9	120.1	9.2	8.2
SCIENCE AND ENGINEERING EDUCATION					
Research Career Development	20.3	27.3	27.3	—0—	—0—
College Science Instrumentation	—0—	5.0	5.0	—0—	—0—
Material Development and Research	23.4	22.7	22.7	—0—	—0—
Teacher Enhancement and Informal Science Education	11.9	25.0	25.0	—0—	—0—
Studies and Program Assessment	1.8	2.0	2.0	—0—	—0—
Total, Science and Engineering Education	57.4	82.0	82.0	—0—	—0—
SPECIAL FOREIGN CURRENCY	2.9	2.8	1.0	-1.8	-64.3
Total, NSF	**$1,306.9**	**$1,502.7**	**$1,600.9**	**$98.2**	**6.5**

SUMMARY BUDGET INFORMATION BY ACTIVITY AND SUBACTIVITY FY 1984-FY 1986

The following table summarizes the National Science Foundation's FY 1984 through FY 1986 budgets by appropriation title.

Activity	*Actual FY 1984*	*Current Request FY 1985*	*Plan FY 1985*	*Estimate FY 1986*	*Difference FY 1986/85*
A. **Summary of Funding Level by Activity**					
Research and Related Activities					
Mathematical and Physical Sciences	$355,046,031	$416,710,000	$396,622,000	$428,970,000	$32,348,000
Engineering	128,614,515	147,100,000	150,037,000	170,070,000	20,033,000
Biological, Behavioral and Social Sciences	223,401,248	253,120,000	251,967,000	272,050,000	20,083,000
Astronomical, Atmospheric, Earth and Ocean Sciences	328,635,030	373,480,000	351,728,249	372,170,000	20,441,751
Scientific, Technological and International Affairs	36,211,148	46,900,000	44,460,000	38,360,000	-6,100,000
Advanced Scientific Computing	6,009,400	—0—	41,460,000	46,230,000	4,770,000
Program Development and Management	66,256,632	70,902,00	70,689,000	69,900,000	-789,000
Subtotal, Research and Research Activities	1,144,174,004	1,308,212,000	1,306,963,249	1,397,750,000	90,786,751
Unobligated Balances and Other Adjustments	-914,004	—0—	-5,051,249	—0—	5,051,249
Research and Related Activities Appropriation	1,142,260,000	1,308,212,000	1,301,912,000	1,397,750,000	95,838,000
U.S. ANTARCTIC PROGRAM ACTIVITIES					
U.S. Antarctic Research Program	10,432,804	11,000,000	11,000,000	11,500,000	500,000
Operations Support	91,954,900	104,080,000	99,898,296	108,600,000	8,701,704
Subtotal, U.S. Antarctic Program Activities	102,387,704	115,080,000	110,898,296	120,100,000	9,201,704
Unobligated Balances and Other Adjustments	68,296	—0—	-68,296	—0—	68,296
U.S. Antarctic Program Activities Appropriation	102,456,000	115,080,000	110,830,000	120,100,000	9,270,000
Science and Engineering Education Activities Appropriation					
Research Career Development	20,311,329	21,000,000	27,300,000	27,300,000	—0—
College Science Instrumentation	—0—	—0—	5,000,000	5,000,000	—0—
Material Development and Research	23,432,567	27,700,000	22,700,000	22,700,000	—0—
Teacher Enhancement and Informal Science Education	11,890,402	25,000,000	25,000,000	25,000,000	—0—
Studies and Program Assessment	1,809,084	2,000,000	2,000,000	2,000,000	—0—
Subtotal, Science and Engineering Education Activities	57,443,382	75,700,000	82,000,000	82,000,000	—0—
Unobligated Balances and Other Adjustments	17,556,618	—0—	5,000,000	-31,450,278	-36,450,278
Science and Engineering Education Activities Appropriation	75,000,000	75,700,000	87,000,000	50,549,722	-36,450,278
Special Foreign Currency Appropriation Research and Related Activities	2,910,776	2,800,000	2,837,457	1,000,000	-1,837,457
Unobligated Balances and Other Adjustments	-10,776	—0—	-37,457	—0—	37,457
Special Foreign Currency Appropriation	**2,900,000**	**2,800,000**	**2,800,000**	**1,000,000**	**-1,800,000**
TOTAL, NSF APPROPRIATIONS	**1,322,616,000**	**1,501,792,000**	**1,502,542,000**	**1,569,399,722**	**66,857,722**

Level of Funding by Program—Continued

Activity	*Actual FY 1984*	*Request FY 1985*	*Current Plan FY 1985*	*Estimate FY 1986*	*Difference FY 1986/85*
B. Mathematical and Physical Sciences					
I. Mathematical Sciences					
Classical Analysis	$3,928,462	$4,800,000	$4,586,000	$5,355,000	$769,000
Modern Analysis	4,070,599	4,950,000	4,712,000	5,490,000	778,000
Geometric Analysis	3,857,881	4,700,000	4,438,000	5,220,000	782,000
Topology and Foundations	5,020,446	5,850,000	5,696,000	6,635,000	939,000
Algebra and Number Theory	6,607,327	7,850,000	7,828,000	9,110,000	1,282,000
Applied Mathematics	5,329,501	6,700,000	6,403,000	7,640,000	1,237,000
Statistics and Probability	4,660,603	6,000,000	5,627,000	6,690,000	1,063,000
Special Projects	7,759,262	9,650,000	8,200,000	8,550,000	350,000
Subtotal	$41,234,081	$50,500,000	$47,490,000	$54,690,000	$7,200,000
II. Computer Research					
Theoretical Computer Science	$3,862,933	$4,300,000	$4,100,000	$4,750,000	$650,000
Software Systems Science	3,671,240	4,200,000	4,000,000	4,400,000	400,000
Software Engineering	3,390,156	3,700,000	3,500,000	3,850,000	350,000
Intelligent Systems	3,383,281	3,650,000	5,400,000	5,400,000	—0—
Computer Systems Design	3,540,560	4,000,000	3,800,000	4,180,000	380,000
Coordinated Experimental Research	13,553,139	16,700,000	15,702,000	16,300,000	598,000
Special Projects	924,047	1,150,000	1,090,000	1,060,000	-30,000
Computer Research Equipment	1,394,956	1,650,000	1,500,000	1,790,000	290,000
Subtotal	$33,720,312	$39,350,000	$39,092,000	$41,730,000	$2,638,000
III. Physics					
Elementary Particle Physics	$35,071,236	$42,500,000	$40,500,000	$44,770,000	$4,270,000
Intermediate Energy Nuclear Physics	16,662,422	19,150,000	18,300,000	18,800,000	500,000
Nuclear Physics	22,126,570	24,820,000	23,200,000	23,400,000	200,000
Atomic, Molecular, and Plasma Physics	12,373,270	13,600,000	13,000,000	13,700,000	700,000
Theoretical Physics	12,343,480	13,800,000	13,500,000	14,400,000	900,000
Gravitational Physics	5,794,525	7,900,000	7,060,000	8,300,000	1,240,000
Subtotal	$104,371,503	$121,770,000	$115,560,000	$123,370,000	$7,810,000
IV. Chemistry					
Structural Chemistry and Thermodynamics	$13,755,501	$15,470,000	$15,100,000	$15,910,000	$810,000
Chemical Physics	13,238,155	14,780,000	14,120,000	15,190,000	1,070,000
Chemical Dynamics	14,266,386	16,950,000	15,370,000	15,990,000	620,000
Chemical Analysis	10,096,771	10,960,000	11,590,000	12,610,000	1,020,000
Synthetic Inorganic and Organometallic Chemistry	8,101,314	9,120,000	9,560,000	10,360,000	800,000
Synthetic Organic and Natural Products Chemistry	9,758,847	11,310,000	11,160,000	11,930,000	770,000
Chemical Instrumentation	10,209,971	13,500,000	10,500,000	11,510,000	1,010,000
Subtotal	$79,426,945	$92,090,000	$87,400,000	$93,500,000	$6,100,000
V. Materials Research					
Solid State Physics	$10,635,521	$12,220,000	$11,440,000	$12,400,000	$960,000
Solid State Chemistry	7,617,101	8,990,000	8,250,000	9,100,000	850,000
Low Temperature Physics	7,217,092	8,180,000	7,850,000	8,400,000	550,000
Condensed Matter Theory	7,487,218	8,890,000	8,220,000	8,900,000	680,000
Metallurgy	8,912,557	10,300,000	9,540,000	10,200,000	660,000
Ceramics and Electronic Materials	5,535,092	6,870,000	6,210,000	6,780,000	570,000
Polymers	6,362,935	7,570,000	6,860,000	7,600,000	740,000
Instrumentation for Materials Research	6,208,579	7,780,000	6,800,000	6,600,000	-200,000
Materials Research Laboratories	26,040,467	30,090,000	28,300,000	30,000,000	1,700,000
National Facilities	10,276,628	12,110,000	11,500,000	12,000,000	500,000
Materials Research Groups	—0—	—0—	2,110,000	3,700,000	1,590,000
Subtotal	$96,293,190	$113,000,000	$107,080,000	$115,680,000	$8,600,000
TOTAL, MATHEMATICAL AND PHYSICAL SCIENCES	$355,046,031	$416,710,000	$396,622,000	$428,970,000	$32,348,000

Level of Funding by Program—Continued

Activity	*Actual FY 1984*	*Request FY 1985*	*Current Plan FY 1985*	*Estimate FY 1986*	*Difference FY 1986/85*
C. **Engineering**					
I. **Chemical, Biochemical, and Thermal Engineering**					
Kinetics and Catalysis Engineering	$3,018,409	$3,320,000	$3,200,000	$3,450,000	$250,000
Biochemical and Biomass Engineering	3,233,392	3,300,000	3,000,000	2,880,000	-120,000
Process and Reaction Engineering	3,228,772	3,400,000	3,400,000	3,230,000	-170,000
Multiphase and Interfacial Phenomena	3,668,519	4,540,000	3,600,000	3,600,000	—0—
Separation and Purification Processes	2,300,563	3,040,000	3,150,000	3,500,000	350,000
Thermodynamics and Transport Phenomena	4,337,938	4,600,000	4,210,000	4,440,000	230,000
Thermal Systems and Engineering	8,939,295	10,760,000	8,800,000	8,260,000	-540,000
Subtotal	$28,726,888	$32,960,000	$29,360,000	$29,360,000	$ —0—
II. **Mechanics, Structures, and Materials Engineering**					
Solid Mechanics	$5,598,966	$6,470,000	$5,600,000	$5,660,000	$60,000
Structures and Building Systems	4,257,320	4,800,000	4,400,000	4,400,000	—0—
Fluid Dynamics and Hydraulics	5,778,378	6,350,000	5,300,000	5,400,000	100,000
Tribology	1,167,139	1,400,000	1,980,000	2,040,000	60,000
Dynamic Systems and Control	2,945,454	3,125,000	2,750,000	2,850,000	100,000
Materials Engineering and Processing	3,007,414	3,470,000	3,000,000	3,300,000	300,000
Subtotal	$22,754,671	$25,615,000	$23,030,000	$23,650,000	$620,000
III. **Electrical, Communications, and Systems Engineering**					
Solid State and Microstructures	$6,778,346	$7,850,000	$7,220,000	$7,700,000	$480,000
Communications Systems and Signal Processing	4,683,688	5,745,000	5,200,000	5,200,000	—0—
Systems Theory and Operations Research	5,124,421	5,685,000	5,000,000	5,200,000	200,000
Quantum, Electric Waves and Beams	4,932,165	5,890,000	5,000,000	4,600,000	-400,000
Instrumentation, Sensing and Measurement	2,151,321	2,500,000	2,980,000	3,980,000	1,000,000
Subtotal	$23,669,941	$27,670,000	$25,400,000	$26,680,000	$1,280,000
IV. **Design, Manufacturing, and Computer Engineering**					
Computer Engineering	$3,966,524	$4,650,000	$5,000,000	$5,460,000	$460,000
Design Theory and Methodology	333,357	495,000	1,600,000	3,000,000	1,400,000
Computer-Integrated Engineering	499,507	800,000	1,630,000	3,000,000	1,370,000
Manufacturing Systems	4,484,138	4,920,000	4,970,000	4,970,000	—0—
Automation and Systems Integration	1,495,680	1,850,000	3,960,000	3,960,000	—0—
Subtotal	$10,779,206	$12,715,000	$17,160,000	$20,390,000	$3,230,000

Level of Funding by Program—Continued

Activity	*Actual FY 1984*	*Request FY 1985*	*Current Plan FY 1985*	*Estimate FY 1986*	*Difference FY 1986/85*
V. **Emerging and Critical Engineering Systems**					
Biotechnology	$606,261	$1,000,000	$1,956,000	$4,300,000	$2,344,000
Bioengineering and Research for the Handicapped	4,643,321	5,460,000	4,580,000	4,680,000	100,000
Lightwave Technology	1,520,661	1,600,000	1,500,000	3,000,000	1,500,000
Earthquake Hazard Mitigation	16,755,679	19,960,000	17,200,000	16,400,000	-800,000
Natural and Man-Made Hazard Mitigation	1,340,816	1,620,000	1,980,000	2,060,000	80,000
Environmental Engineering	5,800,227	5,900,000	5,400,000	5,480,000	80,000
Systems Engineering for Large Structures	2,012,584	2,600,000	2,491,000	2,580,000	89,000
Subtotal	$32,679,549	$38,140,000	$35,107,000	$38,500,000	$3,393,000
VI. **Cross-Disciplinary Research**					
Engineering Research Centers	$ —0—	$10,000,000	$9,990,000	$25,000,000	$15,010,000
Industry/University Research Centers	2,990,721	(3,000,000)	3,000,000	3,000,000	—0—
Industry/University Research Projects	7,013,539	(7,000,000)	6,990,000	3,490,000	-3,500,000
Subtotal	$10,004,260	$10,000,000	$19,980,000	$31,490,000	$11,510,000
TOTAL, ENGINEERING	$128,614,515	$147,100,000	$150,037,000	$170,070,000	$20,033,000
D. **Biological, Behavioral, and Social Sciences**					
I. **Molecular Biosciences**					
Biological Instrumentation	$6,132,120	$7,900,000	$7,710,000	$8,410,000	$700,000
Biochemistry	12,599,148	14,650,000	14,001,000	15,749,000	1,748,000
Biophysics	12,578,518	14,385,000	13,910,000	15,310,000	1,400,000
Prokaryotic Genetics	7,557,028	8,500,000	8,110,000	8,960,000	850,000
Metabolic Biology	13,077,821	15,400,000	14,701,000	15,701,000	1,000,000
Alternative Biological Resources	2,206,436	2,585,000	2,500,000	—0—	-2,500,000
Subtotal	$54,151,071	$63,420,000	$60,932,000	$64,130,000	$3,198,000
II. **Cellular Biosciences**					
Cell Biology	$10,422,554	$11,600,000	$11,000,000	$11,670,000	$670,000
Cellular Physiology	7,534,694	8,330,000	8,045,000	8,650,000	605,000
Developmental Biology	12,209,134	14,400,000	13,740,000	14,640,000	900,000
Eukaryotic Genetics	7,808,440	8,650,000	8,500,000	9,220,000	720,000
Regulatory Biology	9,316,393	9,960,000	9,570,000	10,200,000	630,000
Subtotal	$47,291,215	$52,940,000	$50,855,000	$54,380,000	$3,525,000
III. **Biotic Systems and Resources**					
Ecological Science					
Ecology	$7,922,804	$9,280,000	$9,065,800	$10,050,900	$985,100
Ecosystem Studies	16,471,195	18,460,000	17,968,100	19,300,000	1,331,900
Subtotal	$24,393,999	$27,740,000	$27,033,900	$29,350,900	$2,317,000
Systematic and Population Biology					
Systematic Biology	$10,928,545	$12,330,000	$12,013,300	$13,023,300	$1,010,000
Population Biology and Physiological Ecology	8,986,839	10,040,000	9,767,600	10,667,500	899,900
Biological Research Resources	8,645,450	9,770,000	9,585,200	9,978,300	393,100
Subtotal	$28,560,834	$32,140,000	$31,366,100	$33,669,100	$2,303,000
Subtotal	$52,954,833	$59,880,000	$58,400,000	$63,020,000	$4,620,000

Level of Funding by Program—Continued

Activity	*Actual FY 1984*	*Request FY 1985*	*Current Plan FY 1985*	*Estimate FY 1986*	*Difference FY 1986/85*
IV. Behavioral and Neural Sciences					
Neuroscience					
Molecular and Cellular Neurobiology	$4 796 100	$5 300 000	$5 200 000	$5 550 000	$350 000
Integrative Neural Systems	3 946 354	5 000 000	4 900 000	5 200 000	300 000
Developmental Neuroscience	4 577 655	5 480 000	5 270 000	5 650 000	380 000
Sensory Physiology and Perception	6 270 770	7 300 000	7 200 000	7 650 000	450 000
Psychobiology	4 521 439	4 400 000	4 400 000	4 730 000	330 000
Subtotal	$24 112 318	$27 480 000	$26 970 000	$28 780 000	$1 810 000
Cognitive Science					
Memory and Cognitive Processes	$2 617 236	$2 800 000	$4 500 000	$4 600 000	$100 000
Social and Developmental Psychology	2 433 491	2 700 000	3 100 000	3 230 000	130 000
Linguistics	2 475 595	2 500 000	3 100 000	3 220 000	120 000
Subtotal	$7 526 322	$8 000 000	$10 700 000	$11 050 000	$350 000
Anthropology					
Anthropology	$6 599 781	$6 800 000	$6 700 000	$7 300 000	$600 000
Subtotal	$38 238 421	$42 280 000	$44 370 000	$47 130 000	$2 760 000
V. Social and Economic Science					
Economics and Geography					
Economics	$9 368 865	$10 250 000	$10 180 000	$14 340 000	$4 160 000
Geography	1 012 329	1 300 000	1 340 000	1 600 000	260 000
Subtotal	$10 381 194	$11 550 000	$11 520 000	$15 940 000	$4 420 000
Social Measurement and Analysis					
Sociology	$3 050 944	$3 650 000	$3 850 000	$4 200 000	$350 000
Measurement Methods and Data Improvement	3 653 519	3 400 000	3 430 000	3 800 000	370 000
History and Philosophy of Science	1 348 044	1 600 000	1 690 000	2 200 000	510 000
Subtotal	$8 052 507	$8 650 000	$8 970 000	$10 200 000	$1 230 000
Political and Policy Sciences					
Political Science	$2 727 943	$3 600 000	$3 600 000	$4 100 000	$500 000
Law and Social Sciences	1 397 944	1 700 000	1 840 000	2 200 000	360 000
Regulation and Policy Analysis	1 057 944	1 300 000	1 290 000	—0—	-1 290 000
Decision and Management Science	972 117	1 200 000	1 290 000	1 450 000	160 000
Subtotal	$6 155 948	$7 800 000	$8 020 000	$7 750 000	$-270 000
Subtotal	$24 589 649	28 000 000	$28 510 000	$33 890 000	$5 380 000
VI. Information Science and Technology					
Information Science	$4 039 971	$4 000 000	$5 400 000	$5 500 000	$100 000
Information Technology	1 053 626	1 300 000	1 750 000	2 000 000	250 000
Information Impact	1 082 462	1 300 000	1 750 000	2 000 000	250 000
Subtotal	$6 176 059	$6 600 000	$8 900 000	$9 500 000	$600 000
TOTAL, BIOLOGICAL, BEHAVIORAL AND SOCIAL SCIENCES	$223 401 248	$253 120 000	$251 967 000	$272 050 000	$20 083 000

Level of Funding by Program—Continued

Activity	*Actual FY 1984*	*Request FY 1985*	*Current Plan FY 1985*	*Estimate FY 1986*	*Difference FY 1986/85*
E. **Astronomical, Atmospheric, Earth, and Ocean Sciences**					
I. **Astronomical Sciences**					
Astronomy Project Support					
Solar System Astronomy	$1,307,638	$1,270,000	$1,250,000	$1,300,000	$50,000
Stars and Stellar Evolution	6,301,686	6,490,000	6,057,000	6,600,000	543,000
Galactic Astronomy	4,558,000	5,290,000	4,887,000	5,000,000	113,000
Extragalactic Astronomy	5,909,200	7,520,000	7,066,000	8,200,000	1,134,000
Astronomical Instrumentation and Development	9,604,746	8,230,000	8,057,000	7,360,000	-697,000
Electromagnetic Spectrum Management	100,000	100,000	100,000	100,000	—0—
Subtotal	$27,781,270	$28,900,000	$27,417,000	$28,560,000	$1,143,000
National Astronomy and Ionosphere Center					
Scientific Research Support	$6,426,433	$6,615,000	$6,415,000	$6,665,000	$250,000
Less NASA Support	-315,000	-315,000	-315,000	-315,000	—0—
Subtotal	$6,111,433	$6,300,000	$6,100,000	$6,350,000	$250,000
National Optical Astronomy Observatories					
Scientific Research Support	$23,112,001	$24,749,000	$22,937,000	$24,068,000	$1,131,000
Management Fee	463,000	486,000	378,000	417,000	39,000
Less DOD Support	-415,000	-435,000	-435,000	-435,000	—0—
Subtotal	$23,160,001	$24,800,000	$22,880,000	$24,050,000	$1,170,000
National Radio Astronomy Observatory					
Scientific Research Support	$19,930,000	$33,070,000	$17,300,000	$17,830,000	$530,000
VLBA Construction	—0—	(15,000,000)	9,000,000	11,500,000	2,500,000
Management Fee	330,000	330,000	350,000	380,000	30,000
Subtotal	$20,260,000	$33,400,000	$26,650,000	$29,710,000	$3,060,000
Subtotal	$77,312,704	$93,400,000	$83,047,000	$88,670,000	$5,623,000
II. **Atmospheric Sciences**					
Atmospheric Sciences Project Support					
Aeronomy	$6,275,240	$6,550,000	$6,456,000	$6,701,000	$245,000
Atmospheric Chemistry	6,621,575	7,250,000	6,983,000	7,249,000	266,000
Climate Dynamics	7,173,891	7,790,000	7,560,000	7,848,000	288,000
Experimental Meteorology	5,019,498	5,640,000	5,312,000	5,514,000	202,000
Global Atmospheric Research Program (GARP)	4,833,000	4,500,000	4,278,000	3,900,000	-378,000
Meteorology	8,316,279	9,100,000	8,843,000	9,720,000	877,000
Solar Terrestrial Research	7,064,500	7,690,000	7,431,000	7,713,000	282,000
Subtotal	$45,303,983	$48,520,000	$46,863,000	$48,645,000	$1,782,000

Level of Funding by Program—Continued

Activity	*Actual* FY 1984	*Request* FY 1985	*Current Plan* FY 1985	*Estimate* FY 1986	*Difference* FY 1986/85
National Center for Atmospheric Research					
Atmospheric Analysis and Prediction	$3,504,700	$3,645,000	$3,591,000	$3,727,000	$136,000
Atmospheric Chemistry	2,752,585	2,863,000	2,718,000	2,821,000	103,000
Convective Storms	2,306,630	2,386,000	2,397,000	2,488,000	91,000
Advanced Study Program	1,360,200	1,535,000	1,392,000	1,445,000	53,000
High Altitude Observatory	3,376,860	3,456,000	3,480,000	3,613,000	133,000
Atmospheric Technology	6,836,162	7,472,000	7,181,000	7,454,000	273,000
Scientific Computing	9,875,950	13,425,000	11,571,000	11,821,000	250,000
Administration and Support Services	4,659,050	4,928,000	5,079,000	5,273,000	194,000
Physical Plant Operation and Maintenance	3,716,636	5,269,000	5,051,000	5,243,000	192,000
Contractor Fee	957,634	941,000	984,000	1,021,000	37,000
Subtotal	$39,346,407	$45,920,000	$43,444,000	$44,906,000	$1,462,000
Upper Atmospheric Research Facility	$3,729,500	$4,100,000	$3,939,000	$4,089,000	$150,000
Subtotal	$88,379,890	$98,540,000	$94,246,000	$97,640,000	$3,394,000
III. **Earth Sciences**					
Stratigraphy and Paleontology	$3,699,952	$3,900,000	$3,800,000	$3,800,000	$ —0—
Surficial Processes	2,700,000	2,900,000	2,900,000	2,900,000	—0—
Crustal Structure and Tectonics	3,970,584	4,000,000	3,900,000	3,900,000	—0—
Seismology	4,735,488	5,000,000	4,600,000	4,600,000	—0—
Experimental and Theoretical Geophysics	4,763,414	5,000,000	4,900,000	4,900,000	—0—
Petrogenesis and Mineral Resources	3,899,620	4,100,000	4,000,000	4,000,000	—0—
Volcanology and Mantle Geochemistry	3,599,917	3,900,000	3,700,000	3,700,000	—0—
Experimental and Theoretical Geochemistry	5,716,625	6,100,000	6,000,000	6,000,000	—0—
Instrumentation and Facilities	4,599,600	6,000,000	5,056,000	6,300,000	1,244,000
Continental Lithosphere	3,700,000	7,700,000	7,000,000	11,400,000	4,400,000
Subtotal	$41,385,200	$48,600,000	$45,856,000	$51,500,000	$5,644,000
IV. **Ocean Sciences**					
Ocean Science Research Support					
Physical Oceanography	$15,592,846	$17,200,000	$16,800,000	$17,250,000	$450,000
Marine Chemistry	11,957,563	13,400,000	12,500,000	12,940,000	440,000
Submarine Geology and Geophysics	14,613,081	16,100,000	15,250,000	15,700,000	450,000
Biological Oceanography	12,924,264	14,200,000	13,607,000	14,050,000	443,000
Subtotal	$55,087,754	$60,900,000	$58,157,000	$59,940,000	$1,783,000
Oceanographic Facilities Support	$32,894,077	$36,440,000	$34,909,000	$36,790,000	$1,881,000
Ocean Drilling Program					
Ocean Drilling Program	$33,268,812	$37,600,000	$37,600,000	$41,350,000	$3,750,000
Less Foreign Funding	-5,329,665	-10,000,000	-10,000,000	-12,500,000	-2,500,000
Less Other U.S. Agency Funds	-1,645,150	—0—	—0—	—0—	—0—
Subtotal	$26,293,997	$27,600,000	$27,600,000	$28,850,000	$1,250,000
Subtotal	$114,275,828	$124,940,000	$120,666,000	$125,580,000	$4,914,000
V. **Arctic Research Program**					
Arctic Research Projects	$7,281,408	$8,000,000	$7,733,249	$8,100,000	$366,751
Arctic Research and Policy Act Support	—0—	—0—	180,000	680,000	500,000
Subtotal	$7,281,408	$8,000,000	$7,913,249	$8,780,000	$866,751
TOTAL, ASTRONOMICAL, ATMOSPHERIC, EARTH AND OCEAN SCIENCES	$328,635,030	$373,480,000	$351,728,249	$372,170,000	$20,441,751

Level of Funding by Program—Continued

Activity	*Actual FY 1984*	*Request FY 1985*	*Current Plan FY 1985*	*Estimate FY 1986*	*Difference FY 1986 85*
F. Scientific, Technological, and International Affairs					
I. Industrial Science and Technological Innovation					
Industry University Cooperative Research Projects	($6,964,947)	$7,000,000	($6,990,000)	$7,000,000	$10,000
Small Business Innovation Research	7,098,044	12,400,000	12,400,000	13,300,000	900,000
Industry University Cooperative Research Centers	(2,970,000)	3,000,000	(3,000,000)	3,000,000	—0—
Productivity Improvement Research	994,599	1,000,000	1,000,000	—0—	-1,000,000
Subtotal	$8,092,643	$23,400,000	$13,400,000	$13,300,000	$-100,000
II. International Cooperative Scientific Activities					
International Cooperative Science	$11,858,928	$4,400,000	$12,490,000	$11,390,000	$-1,100,000
International Scientific Organizations and Resources	1,077,249	1,100,000	1,100,000	700,000	-400,000
Subtotal	$12,936,177	$5,500,000	$13,590,000	$12,090,000	$-1,500,000
III. Policy Research and Analysis					
Science and Innovation Policy	$1,732,500	$1,800,000	$1,800,000	$ —0—	$-1,800,000
Policy Sciences	1,850,500	1,800,000	1,800,000	—0—	-1,800,000
Technology and Resource Policy	1,000,999	1,100,000	1,090,000	—0—	-1,090,000
Policy Research and Analysis	—0—	—0—	—0—	1,990,000	1,990,000
Subtotal	$4,583,999	$4,700,000	$4,690,000	$1,990,000	$-2,700,000
IV. Science Resources Studies					
Scientific and Technical Personnel	$2,355,965	$2,100,000	$2,090,000	$2,090,000	$ —0—
Funding of Science and Technology	994,576	1,400,000	1,400,000	1,300,000	-100,000
Modeling & Special Science and Technology Indicators	827,138	800,000	800,000	600,000	-200,000
Subtotal	$4,177,679	$4,300,000	$4,290,000	$3,990,000	$-300,000
V. Research Initiation and Improvement					
Visiting Professorships for Women	$2,057,352	$2,000,000	$2,000,000	$2,000,000	$ —0—
Research Opportunities for Women	—0—	500,000	(500,000)	(1,000,000)	(500,000)
Minority Research Initiation	(2,480,000)	2,500,000	(2,500,000)	(2,500,000)	—0—
Research Improvement in Minority Institutions	2,475,000	2,500,000	4,990,000	4,990,000	—0—
Intergrovernmental Science and Technology	495,000	500,000	500,000	—0—	-500,000
Ethics and Values in Science and Technology	990,000	1,000,000	1,000,000	—0—	-1,000,000
Experimental Program to Stimulate Competitive Research	(137,392)	—0—	(1,000,000)	(2,000,000)	(1,000,000)
NSF Planning and Evaluation	403,298	—0—	(2,000,000)	(2,000,000)	—0—
Support for Predominantly Undergraduate Institutions	(41,243,253)	(42,422,000)	(42,400,000)	(44,400,000)	(2,000,000)
Subtotal	$6,420,650	$9,000,000	$8,490,000	$6,990,000	$-1,500,000
TOTAL, SCIENTIFIC, TECHNOLOGICAL AND INTERNATIONAL AFFAIRS	$36,211,148	$46,900,000	$44,460,000	$38,360,000	$-6,100,000

Level of Funding by Program—Continued

Activity	*Actual FY 1984*	*Request FY 1985*	*Current Plan FY 1985*	*Estimate FY 1986*	*Difference FY 1986/85*
G. Advanced Scientific Computing					
Advanced Scientific Computing	$6,009,400	$(20,000,000)	$41,460,000	$46,230,000	$4,770,000
H. Program Development and Management					
Program Development and Management	$66,256,632	$70,902,000	$70,689,000	$69,900,000	$-789,000
Full-time Equivalent Permanent	1,039	1,053	1,053	1,033	-20
Full-time Equivalent Other	142	141	141	141	—0—
Subtotal	1,181	1,194	1,194	1,174	-20
TOTAL, RESEARCH AND RELATED ACTIVITIES	$1,144,174,004	$1,308,212,000	$1,306,963,249	$1,397,750,000	$90,786,751
Unobligated Balances and Other Adjustments	-1,914,004	—0—	-5,051,249	—0—	5,051,249
Research and Related Activities Appropriation	$1,142,260,000	$1,308,212,000	$1,301,912,000	$1,397,750,000	$95,838,000
I. U.S. Antarctic Program					
I. U.S. Antarctic Research Program					
U.S. Antarctic Research Program	$10,432,804	$11,000,000	$11,000,000	$11,500,000	$500,000
II. Operations Support Program					
Direct Science Support	$12,054,900	$11,800,000	$13,780,000	$15,300,000	$1,520,000
Base Level Support	60,400,000	68,980,000	67,818,296	70,000,000	2,181,704
Major Construction and Procurement	19,500,000	23,300,000	18,300,000	23,300,000	5,000,000
Subtotal	$91,954,900	$104,080,000	$99,898,296	$108,600,000	$8,701,704
TOTAL, U.S. ANTARCTIC PROGRAM	$102,387,704	$115,080,000	$110,898,296	$120,100,000	$9,201,704
Unobligated Balances and Other Adjustments	68,296	—0—	-68,296	—0—	68,296
U.S. Antarctic Program Activities Appropriation	$102,456,000	$115,080,000	$110,830,000	$120,100,000	$9,270,000
J. Science and Engineering Education					
Research Career Development	$20,311,329	$21,000,000	$27,300,000	$27,300,000	$ —0—
College Science Instrumentation	—0—	—0—	5,000,000	5,000,000	—0—
Materials Development and Research	23,432,567	27,700,000	22,700,000	22,700,000	—0—
Teacher Enhancement and Informal Science Education	11,890,402	25,000,000	25,000,000	25,000,000	—0—
Studies and Program Assessment	1,809,084	2,000,000	2,000,000	2,000,000	—0—
TOTAL, SCIENCE AND ENGINEERING EDUCATION	$57,443,382	$75,700,000	$82,000,000	$82,000,000	$ —0—
Unobligated Balances and Other Adjustments	17,556,618	—0—	5,000,000	-31,450,278	-36,450,278
Science and Engineering Education Activities Appropriation	$75,000,000	$75,700,000	$87,000,000	$50,549,722	$-36,450,278

Level of Funding by Program—Continued

Activity	*Actual FY 1984*	*Request FY 1985*	*Current Plan FY 1985*	*Estimate FY 1986*	*Difference FY 1986/85*
K. Special Foreign Currency Program					
Special Foreign Currency	$2,910,776	$2,800,000	$2,837,457	$1,000,000	$-1,837,457
Unobligated Balances and Other Adjustments	-10,776	—0—	-37,457	—0—	37,457
Special Foreign Currency Program Appropriation	$2,900,000	$2,600,000	$2,800,000	$1,000,000	$-1,800,000
TOTAL, NSF APPROPRIATION	**$1,322,616,000**	**$1,501,792,000**	**$1,502,542,000**	**$1,569,399,722**	**$66,857,722**

Numbers enclosed in parentheses are non-adds for comparison purposes only

FY 1984 Actual obligations have been adjusted to permit comparison with programmatic changes reflected in the FY 1985 Current Plan and the FY 1986 Estimate

National Science Foundation

RESEARCH AND RELATED ACTIVITIES APPROPRIATION

ANALYSIS OF CHANGES IN OBLIGATED LEVELS

FY 1984—FY 1986

	Obligations
FY 1984 Obligated Level	$1,144,174,004
FY 1985:	
Increases:	
Mathematical and Physical Sciences	41,575,969
Engineering	21,422,485
Biological, Behavioral and Social Sciences	28,565,752
Astronomical, Atmospheric, Earth and Ocean Sciences	23,093,219
Scientific, Technological and International Affairs	8,248,852
Advanced Scientific Computing	35,450,600
Program Development and Management	4,432,368
Subtotal	162,789,245
FY 1985 Obligated Level	1,306,963,249
FY 1986	
Increases:	
Mathematical and Physical Sciences	32,348,000
Engineering	20,033,000
Biological, Behavioral and Social Sciences	20,083,000
Astronomical, Atmospheric, Earth and Ocean Sciences	20,441,751
Advanced Scientific Computing	4,770,000
Subtotal	97,675,751
Decreases:	
Scientific, Technological and International Affairs	-6,100,000
Program Development and Management	-789,000
Subtotal	-6,889,000
FY 1986 Obligated Level	$1,397,750,000

U.S. ANTARCTIC PROGRAM ACTIVITIES APPROPRIATION

ANALYSIS OF CHANGES IN OBLIGATED LEVELS

FY 1984—FY 1986

	Obligations
FY 1984 Obligated Level	$102,387,704
FY 1985:	
Increases:	
U.S. Antarctic Research Program	567,196
Operations Support	7,943,396
Subtotal	8,510,592
FY 1985 Obligated Level	110,898,296
FY 1986:	
Increases:	
U.S. Antarctic Research Program	500,000
Operations Support	8,701,704
Subtotal	9,201,704
FY 1986 Obligated Level	**$120,100,000**

National Science Foundation

SCIENCE AND ENGINEERING EDUCATION ACTIVITIES APPROPRIATION

ANALYSIS OF CHANGES IN OBLIGATED LEVELS

FY 1984—FY 1986

	Obligations
FY 1984 Obligated Level	$57,443,382
FY 1985:	
Increases	
Research Career Development	6,988,671
College Science Instrumentation	5,000,000
Teacher Enhancement and Informal Science Education	13,109,598
Studies and Program Assessment	190,916
Subtotal	25,289,185
Decrease	
Material Development and Research	-732,567
FY 1985 Obligated Level	**82,000,000**
FY 1986 Obligated Level	**$82,000,000**

National Science Foundation

SPECIAL FOREIGN CURRENCY APPROPRIATION

ANALYSIS OF CHANGES IN OBLIGATED LEVELS

FY 1984—FY 1986

	Obligations
FY 1984 Obligated Level	$2,910,776
FY 1985:	
Decrease	
Research and Related Activities	-73,319
FY 1985 Obligated Level	2,837,457
FY 1986:	
Decrease	
Research and Related Activities	-1,837,457
FY 1986 Obligated Level	**$1,000,000**

National Science Foundation

PERCENTAGE DISTRIBUTION OF TOTAL OBLIGATIONS

FY 1984—FY 1986

	Actual FY 1984	Request FY 1985	Current Plan FY 1985	Estimate FY 1986
Research and Related Activities				
Mathematical and Physical Sciences	27.2	27.7	26.4	26.8
Engineering	9.8	9.8	10.0	10.6
Biological, Behavioral and Social Sciences	17.1	16.9	16.8	17.0
Astronomical, Atmospheric, Earth and Ocean Sciences	25.1	24.9	23.4	23.2
Scientific, Technological and International Affairs	2.8	3.1	3.0	2.4
Advanced Scientific Computing	0.5	—	2.7	2.9
Program Development and Management	5.1	4.7	4.7	4.4
Subtotal	87.6	87.1	87.0	87.3
U.S. Antarctic Program				
U.S. Antarctic Research Program	0.8	0.7	0.7	0.7
Operations Support	7.0	7.0	6.7	6.8
Subtotal	7.8	7.7	7.4	7.5
Science and Engineering Education				
Research Career Development	1.6	1.4	1.8	1.7
College Science Instrumentation	—	—	0.3	0.3
Material Development and Research	1.8	1.8	1.5	1.4
Teacher Enhancement and Informal Science Education	0.9	1.7	1.7	1.6
Studies and Program Assessment	0.1	0.1	0.1	0.1
Subtotal	4.4	5.0	5.4	5.1
Special Foreign Currency	0.2	0.2	0.2	0.1
Total NSF	100.0	100.0	100.0	100.0

National Science Foundation

SUMMARY OF OBLIGATIONS BY MAJOR OBJECT CLASSIFICATION

Object	*Actual FY 1984*	*Budget Request FY 1985*	*Current Plan FY 1985*	*Estimate FY 1986*	*Difference FY 1986/85*
Research and Related Activities					
Personnel Compensation	$44,746,074	$46,514,000	$46,402,000	$45,720,000	-$682,000
Personnel Benefits	4,572,932	4,728,000	4,807,000	4,661,000	-146,000
Travel and Transportation of Persons	3,056,876	3,500,000	2,935,000	3,000,000	65,000
Transportation of Things	231,749	330,000	310,000	295,000	-15,000
Rents and Communications	7,617,026	8,720,000	8,185,500	8,085,300	-100,200
Printing and Reproduction	451,410	600,000	435,000	435,000	—0—
Other Contractual Services					
Program Contracts	160,609,688	167,037,000	184,204,864	197,850,000	13,645,136
Program Development and Management Contract Services	3,430,122	3,571,000	4,292,500	3,877,900	-414,600
Supplies and Materials	624,938	900,000	785,000	709,800	-75,200
Equipment	1,519,251	2,009,000	2,507,000	3,086,000	579,000
Grants, Subsidies and Contributions					
Program Grants	917,307,684	1,070,273,000	1,052,069,385	1,130,000,000	77,930,615
Program Development and Management Grants	6,254	30,000	30,000	30,000	—0—
Subtotal, Research and Related Activities	1,144,174,004	1,308,212,000	1,306,963,249	1,397,750,000	90,786,751
U.S. Antarctic Program					
Program Contracts	91,133,056	105,580,000	98,781,296	107,600,000	8,818,704
Program Grants	11,254,648	9,500,000	12,117,000	12,500,000	383,000
Subtotal, U.S. Antarctic Program	102,387,704	115,080,000	110,898,296	120,100,000	9,201,704
Science and Engineering Education Activities					
Program Contracts	1,436,085	2,000,000	3,000,000	3,000,000	—0—
Program Grants	56,007,297	73,700,000	79,000,000	79,000,000	—0—
Subtotal, Science and Engineering Education Activities	57,443,382	75,700,000	82,000,000	82,000,000	—0—
Special Foreign Currency					
Travel and Transportation of Persons	207,376	100,000	100,000	200,000	100,000
Program Contracts	50,929	170,000	150,000	150,000	—0—
Program Grants	2,652,471	2,530,000	2,587,457	650,000	-1,937,457
Subtotal, Special Foreign Currency	2,910,776	2,800,000	2,837,457	1,000,000	-1,837,457
Total, NSF	**$1,306,915,866**	**$1,501,792,000**	**$1,502,699,002**	**$1,600,850,000**	**$98,150,998**

NATIONAL SCIENCE FOUNDATION

RESEARCH AND RELATED ACTIVITIES

For necessary expenses in carrying out the purposes of the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), title IX of the National Defense Education Act of 1958 (42 U.S.C. 1876-1879), and the Act to establish a National Medal of Science (42 U.S.C. 1880-1881); services as authorized by 5 U.S.C. 3109; maintenance and operation of aircraft and purchase of flight services for research support; hire of passenger motor vehicles; not to exceed $2,500 for official reception and representation expenses; uniforms or allowances therefor, as authorized by law (5 U.S.C. 5901-5902); rental of conference rooms in the District of Columbia; and reimbursement of the General Services Administration for security guard services; [$1,301,912,000] to remain available until September 30, [1986]: *Provided*, That of the funds appropriated in this Act, or from funds appropriated previously to the Foundation, not more than [$70,302,000] shall be available for program development and management in fiscal year [1985]: *Provided further*, That contracts may be entered into under the program development and management limitation in fiscal year [1985] for maintenance and operation of facilities, and for other services, to be provided during the next fiscal year: *Provided further*, That receipts for scientific support services and materials furnished by the National Research Centers and other National Science Foundation supported research facilities may be credited to this appropriation: *Provided further*, That to the extent that the amount appropriated is less than the total amount authorized to be appropriated for included program activities, all amounts, including floors and ceilings, specified in the authorizing Act for those program activities or their subactivities shall be reduced proportionally[: *Provided further*, That not to exceed $9,000,000 shall be available for the very long baseline array and such funds shall not be obligated before April 1, 1985: *Provided further*, That the Foundation is authorized to indemnify grantees, contractors, and subcontractors associated with the ocean drilling program under the provisions of section 2354 of title 10 of the United States Code, with all approvals and certifications required thereby made by the Director of the National Science Foundation.] (Department of Housing and Urban Department-Independent Agencies Appropriation Act, 1985.)

acquisition of one aircraft;

$1,397,750,000

1987

$69,900,000

1986

1986

Provided further, that notwithstanding the provisions of the Small Business InnovationAct, Public Law 97-219, the rate authorized in fiscal year 1986, for carrying out the Small Business Innovation Research Program shall not exceed the rate authorized for fiscal year 1985 for carrying out this program.

UNITED STATES ANTARCTIC PROGRAM ACTIVITIES

For necessary expenses in carrying out the research and operational support for the U.S. Antarctic Program pursuant to the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875); maintenance and operation of aircraft and purchase of flight services for research and operations support; maintenance and operation of research ships and charter or lease of ships for research and operations support; hire of passenger motor vehicles; not to exceed $1,000 for official reception and representation expenses; [$110,080,000], to remain available until expended: *Provided*, That receipts for support services and materials provided to individuals for non-Federal activities may be credited to this appropriation. *Provided further*, That no funds in this account shall be used for the purchase of aircraft; (Department of Housing and Urban Department-Independent Agencies Appropriation Act, 1985.)

$120,100,000

Provided further, that notwithstanding the provisions of the Small Business Innovation Act, Public Law 97-219, the rate authorized in fiscal year 1986 for carrying out the Small Business Innovation Research Program shall not exceed the rate authorized for fiscal year 1985 for carrying out this program.

AND ENGINEERING

SCIENCE EDUCATION ACTIVITIES

$50,550,000 — 1987

For necessary expenses in carrying out science education programs and activities pursuant to the purposes of the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-1875), including award of graduate fellowships, services as authorized by 5 U.S.C. 3109, and rental of conference rooms in the District of Columbia, [$87,000,000], to remain available until September 30, [1986]: *Provided*, That to the extent that the amount of this appropriation is less than the total amount authorized to be appropriated for included program activities, all amounts, including floors and ceilings, specified in the authorizing Act for those program activities or their subactivities shall be reduced proportionally [: *Provided further*, That $5,000,000 shall be transferred from funds provided under this head to and merged with funds made available under "Research and related activities" for the purpose of conducting research on teaching and learning: *Provided further*, That $2,000,000 shall be made available for a contract to develop a science education plan and management structure for the Foundation]. (Department of Housing and Urban Development-Independent Agencies Appropriation Act, 1985.)

SCIENTIFIC ACTIVITIES OVERSEAS (SPECIAL FOREIGN CURRENCY PROGRAM)

$1,000,000 — 1987

For payments in foreign currencies which the Treasury Department determines to be excess to the normal requirements of the United States, for scientific activities, as authorized by law, [$2,800,000], to remain available until September 30, [1986]: *Provided*, That this appropriation shall be available in addition to other appropriations to the National Science Foundation for payments in the foregoing currencies. (Department of Housing and Urban Development-Independent Agencies Appropriation Act, 1985.)

The CHAIRMAN. Thank you very much, Mr. Bloch; a very good and reasonable budget, in light of the budget constraints that we have facing us.

One of the subjects I have been very interested in, and you talked about it toward the conclusion of your remarks, is about advanced scientific computing.

What are the long-term plans for providing scientists training and access to advanced scientific computational resources at the new centers that you are talking about? How do you plan to provide funds for upgrading and maintaining the centers that have currently been established? And how many supercomputer centers do you intend to fund in the fiscal year 1985-86 budget cycle?

Mr. BLOCH. You are asking a number of questions there, so let me try to answer them all.

First of all, we went out in 1984 with a request for proposals on supercomputer centers. We received over 20 proposals, 21 to be accurate.

Obviously, if you total up all of the request dollars, it would be over $1 billion, and we don't have $1 billion for this particular effort, so we have to be very selective, and we also have to take into consideration the long-term aspects of these centers.

Because of all of that, what we have done so far, and what we are concluding internally, although it has to be approved still by the National Science Board, that in fiscal year 1985 and 1986, we can fund three centers, plus one experimental center, or four centers in total, if you want to include the experimental center, and that would essentially take care pretty much of the 1985 and 1986 funding that we have available for these centers.

Let me make one point. I happened to receive today a letter from a university—namely Rochester University—where the president pleads, and rightly so, that we don't nickel-and-dime the centers, that we establish centers that are worthy of the name, No. 1; that can operate on a long-term kind of a basis, even if that means fewer centers.

And I am in full agreement with this approach. The worst thing you can do is to establish a large number of centers that you cannot support adequately. That is about where we are.

We are with four centers right now, including what I called an experimental center.

We have one more thing to consider. As you know, Congress last year made it possible for us to receive a CRAY machine from NASA, and this will be available sometime toward the end of this year.

We would like to use that machine as part of the center kind of activity, and that would make essentially a fifth center, but it would be a center based on a machine that already exists, and it would be essentially put in place with the idea of later on updating that machine.

So that is about where we are right now. It was a difficult decision, No. 1, because of the number of very, very good proposals that we had.

The second question that you asked, was it the long-term view on these centers? Let me make a couple of points on that.

This is the technology , supercomputers, that is rapidly progressing, that is changing all the time, and therefore, we have to take into consideration, foremost and first, that we continuously upgrade these centers. It wouldn't surprise me at all that after 2 or 3 years, one needs to do a major upgrade of all of these centers in order to keep them at the leading edge of technology and provide the support that is required.

The second thing which has to do with the future of the centers. It is not good enough just to put supercomputers in place. One needs to have access to it.

The access comes in two ways. First way is working the centers together, even on an international scale. Probably one should think that way, because while we are moving forward with supercomputer centers in the United States, in Europe there is a big move under way to put supercomputer centers into universities.

In fact, Europe has taken the approach of interlinking these centers, just like we want to interlink ours, and therefore, networking is a very important aspect, and we cannot forget that.

In fact, many of the dollars that we have allocated this year are research for the networking aspect, first on a very primitive scale. Hopefully later on, it will be on a much broader scale.

The last point I want to say on this subject is also with regard to the future of supercomputers and supercomputing centers. The workstation aspect, and the local stations is very important. The workstations are moving in terms of their capabilities, technologies, and in terms of their costs. The costs are coming down tremendously, and one has to consider the use of workstations in conjunction with these supercomputers.

So we are not just talking about central processing; hardware; we are talking about communication with it and between the researchers, and we are talking about the work stations that these workers have to use.

The CHAIRMAN. Thank you. The committee has been very interested in coming forth with a substantial effort to upgrade the quality and quantity of instrumentation at our universities, and NSF has been interested.

What commitment in the fiscal year 1986 budget do you have for instrumentation upgrading as compared with previous budget years in this area?

Do you think that has a higher priority or what priority do you rate that?

Mr. BLOCH. I rate it as a very high priority but, like anything else, there has to be a balance between that and research, obviously.

In this particular budget, 1986, there are about $270 million allocated in the four research directorates, for instrumentation, and that is the highest number and the highest percent that the National Science Foundation ever allocated in terms of instrumentation.

By the way, I don't include all of Advanced Scientific Computing in that particular number. That is outside of that number but it includes smaller computers, obviously, which are part of the instrumentation process, part of the equipment process, and part of the need for doing the research.

So we are talking about a very large percentage of our funding that is earmarked to instrumentation, and I believe we have to continue to do that in the future.

We let instrumentation fall behind over the last few years, and I think we are slowly recovering, but it is a slow process.

And also, instrumentation is moving at a very fast rate and because of the complexity increase that I talked about before, instrumentation is becoming more and more important.

So we focused on that one very heavily. I think we have about the right balance. It is not enough, I can tell you that right now, and we will hear many complaints that we are underfunding instrumentation.

The Foundation cannot take that problem on by itself. In fact, it doesn't take it on by itself. It has a very high priority with us, and within the balance of the dollars that we have available, we are probably doing as well as we can, but not sufficient in many people's minds, probably also my own.

The CHAIRMAN. Let me commend you, because it appears that you are concerned about that and addressing it in a very favorable fashion. Let me commend you for that.

Without objection, I would like to include the remarks of Mr. Lujan following my opening statement.

Mr. Brown.

Mr. BROWN. Thank you, Mr. Chairman.

Thank you, Mr. Bloch, for your statement. I never know when we have the opportunity to question you, whether to start with those issues on which we may disagree with you, or start with those issues that we are very much interested in and supportive of what you are doing.

Let me start with something that came up in the film which made reference to the research in plant genetics, DNA research, biotechnology, and so forth.

It seems to be that the field of plant genetics is an emerging area which we seem to have neglected in the general support for biotechnology research.

I wonder if you could comment on how much the Foundation is doing, what portion does that represent of the total research that we are funding, and how well coordinated is the resource funding in that area?

Mr. BLOCH. Well, let me say at the outset that plant genetics has a really high priority, but let me also say in a very general way that particular directorate, namely, BBS, has received an 8-percent increase this year and it is roughly equally split across all areas. So we have tried to focus on biotechnology in general and plant genetics in this particular area.

Again I want to say this is an emerging field and a very growing field, just like the whole biotechnology field is a growing field. It has a high priority with us and has had a high priority over the last few years already. There are other things in that directorate besides biotechnology, obviously.

It shows that it is an important and underlines that it is an important area.

Mr. BROWN. I am glad to hear you say that. I have been concerned about the new biotechnology initiative in the Department of

Agriculture, which again the administration is to be commended for supporting as strongly as it did.

But I am concerned in your role with the general question of how well we are looking at this from the standpoint of a total program, in an effort to meet the national needs for taking advantage of developments in this area.

Mr. BLOCH. As I said before, I think we are focusing on this particular area, No. 1.

No. 2, you should also know there is quite a bit of interaction between us, NIH, and the Department of Agriculture and also other agencies that are engaged in this particular area. And we know pretty well what goes on, and we are trying to make it a coordinated kind of effort, as much as that is possible. So we are focusing on that problem, I think.

Mr. BROWN. Are you tracking the situation regarding the level of foreign or non-U.S. citizens as graduate students in the sciences and as faculty members in our research universities? And if so, can you give me a general picture what the developments are? What are the trends?

Mr. BLOCH. I can give you a general picture and provide you with a lot of data.

The answer is, Yes, we are tracking it. In science and engineering, the foreign student component is about 50 percent, roughly speaking. The faculty component, I can't tell you. I don't know but it is also relatively high.

There are a couple of things I want to point out. The trend for Ph.D. candidates is downward in total numbers and that is a really disconcerting situation. So foreign or U.S. citizen doesn't matter. The trend is downward, and we somehow have to arrest that particular trend.

The reasons for it are complex, as you know very well and understand, but it has to do with the differential in salaries, the lack of instrumentation many times has something to do with it, and also the workload on faculty probably has also something to do with it. So I think we should be concerned about it.

We are tracking it very closely, by discipline, and obviously it is different from discipline to discipline. But I think it is something that we need to address.

Some of the programs that we have are trying to address it. The Presidential Young Investigator Award is one program. The other program that is addressing it are the increases over the last couple of years that we put in place for fellowships, and I think that will have helped or should have helped to attract people more to graduate studies and also to faculty positions.

It is a concern. We are tracking it. We can provide you with all kinds of data on it by discipline and be glad to do so.

Mr. BROWN. I would appreciate getting that information if you could provide it.

[The information follows:]

FOREIGN AS A PERCENT OF ALL SCIENCE AND ENGINEERING FULL-TIME GRADUATE STUDENTS IN DOCTORATE-GRANTING INSTITUTIONS: 1975-83

	FULL-TIME GRADUATE STUDENTS		
YEAR	TOTAL	FOREIGN	PERCENT OF TOTAL
1975	210,321	33,128	15.8
1976	214,089	34,400	16.1
1977	217,453	36,856	16.9
1978	216,608	1/	1/
1979	223,409	44,750	20.0
1980	230,535	48,671	21.1
1981	234,194	52,598	22.5
1982	236,939	55,302	23.3
1983	243,646	59,906	24.6

1/ Data on citizenship were not available in 1978.

SOURCE: Division of Science Resources Studies/NSF

FOREIGN AS A PERCENT OF ALL FULL-TIME GRADUATE STUDENTS IN DOCTORATE-GRANTING INSTITUTIONS BY FIELD: 1976, 1980, AND 1983

	FULL-TIME GRADUATE STUDENTS								
	1976			1980			1983		
FIELD	TOTAL	FOREIGN	PERCENT OF TOTAL	TOTAL	FOREIGN	PERCENT OF TOTAL	TOTAL	FOREIGN	PERCENT OF TOTAL
Total	214,089	34,400	16.1	230,535	48,671	21.1	243,646	59,906	24.6
Science	173,575	21,174	12.2	182,696	29,298	16.0	180,835	33,967	18.8
Engineering	36,231	12,221	33.7	41,939	17,503	41.7	53,553	22,409	41.8
Computer sciences	4,283	1,005	23.5	5,900	1,870	31.7	9,258	3,530	38.1

SOURCE: Division of Science Resources Studies/NSF

Mr. **Brown**. I don't have time to discuss a number of other policy areas which are extremely important and need to be tracked and some recommendations made for the solution to the problems—the support for large research facilities, for example.

I am well aware that we are losing researchers from science to industry because that is the most advanced and people prefer to go there.

The question I want to conclude with is this: In light of the multitude of the scientific policy issues that need continued research and analysis, why have you cut the budget for policy research and analysis?

Mr. **Bloch**. Well, let me answer that question.

Mr. **Brown**. By a very substantial percentage, I might indicate, too.

Mr. **Bloch**. Yes, that is correct. About 50 percent, to be very accurate.

Mr. **Brown**. We have 50 percent less policy problems now, do we?

Mr. **Bloch**. No, we don't have 50 percent less policy problems but let me tell you exactly why that was done.

First of all, let me give you a couple numbers. We had 31 or 32 people in this particular activity. The activity served NSF, it served OMB and OSTP and primarily the executive branch, in fact.

Again, it has to do with the budget and with a different budget, your question probably would be moot because it might not have happened.

But with this particular budget, we were faced with some hard decisions, as I said before, and in my opinion—and I am the culprit on this particular point, very clearly, but I decided that we could do with fewer people and therefore less dollars and still do the work that had to be done in this important area.

Last year we generated something like 100 or 120 reports out of this particular group.

I think we can get away with 50 if we are selective in what we are asking for. Many times, I have done it myself in the last few months I have been here, and I know my predecessor did the same. The question comes to mind, do you jot off a note and say, "Look at this particular area." You never ask the question of yourself, is it really worthwhile answering it or, more importantly, can I get my answers some other way?

So I think if one is careful, and understands the limitation on that particular group, then I can get as much out of it as before, I believe. Again, it is not the quantity; it is really the quality of reports that are important.

I feel kind of—let me say it differently. I believe that the reductions that we have made do not cost us any of the quality aspects of that particular function, but it certainly would be able to handle fewer problems. I know that is not completely satisfactory to you, but——

Mr. **Brown**. Well, that is an understatement, Mr. Bloch. You haven't been here long enough to be aware of the emphasis this committee has put on the importance of strategic policy planning.

We have been hectoring your predecessors for a generation on this question and the previous level was inadequate. Maybe the quality of the reports was good, but there is a difference between reports and good policy planning and good policy research.

I don't think that we were getting anywhere near an adequate amount. I think it is because there is a bias against doing policy planning, and it is the easiest part to cut. But it is a weakness which shows up with unsolved problems down the road that we wonder how they got there until they come up and hit us in the face.

Mr. BLOCH. Well, let me assure you that I don't want to underplay the need for what you are describing, but I would suggest that we can do that and not hurt too badly and still be able to reduce the staff and also the expense of that particular effort.

I know I have to prove that to you over time.

Mr. BROWN. We want a list of other places where you can reduce the staff and improve the quality of the product, too.

Mr. WALGREN. The gentleman's time has expired.

The Chair would recognize Mr. Henry.

Mr. HENRY. I have no questions, Mr. Chairman.

Mr. WALGREN. Then if we can, in order of sequence, the Chair would recognize himself for several questions.

Mr. Bloch, the committee has been on an overall level quite impressed with the problem of adequate instrumentation and the size of that problem. How are we measuring our success in addressing it?

I understand that NSF is trying to, through its individual grants, emphasize some strengthening in that area. But what are our measurements of progress? How are we going to know whether or not we are falling behind further or how fast we are reaching a point where we should be?

Mr. BLOCH. Well, as you know, this problem was identified a number of years ago by essentially going around the various universities and research laboratories and taking a look at their investment, No. 1, and also the status of the equipment, the age of the equipment, and also the need versus the availability of that particular equipment.

We have done that continuously in one form or another—not in a very comprehensive kind of form—but we looked at very specific areas, very specific disciplines in that regard.

We have in effect now an NSF-sponsored study to take a more comprehensive look at this particular problem. I think it is only through sampling of the universities' research, the laboratories themselves, that you get a feel for it.

We also are getting a feel for it obviously through some of the feedback we are getting through some proposals and also through the advisory committees.

But we are in part in the process of making a more formal study than just the normal informal kind of studies. That report should be available sometime in the third quarter 1985.

So that would give us also another check point where we can compare ourselves to the previous one and hopefully can draw some conclusions from it, how effective the efforts have been and again what else has to be done in this particular area.

You know, there are many numbers floating around in the area. Everybody has his own number. But I think it takes a more rigorous approach to really focus in and find out what the status is.

The other point I want to make on that, Mr. Chairman, was that only for the last couple of years instrumentation has been focused on. It takes time before you see the results of these initiatives because equipment gets installed much later than when it is approved and also the functioning of the equipment takes some time, and people have to become acquainted with it to bring it up to maximum efficiency.

So if you just listened to people's opinion, I don't think we have seen the impact yet, but I think we want to measure that with more quantitive data.

Mr. WALGREN. The budget, of course, over-all has faired quite well and I particularly want to note that the social and economic scientists as a category have shown some appreciation by the administration—appreciation of their importance and their role in the overall mix of programs.

Can you outline what thrusts in the social science area are in this budget?

You slated for increase, as we move from 1985 to 1986, some of them. Where are you putting the emphasis there?

Mr. BLOCH. I will be glad to comment on it. Let me give you a couple of numbers.

I think this particular area, social and economic science in total, had in NSF a growth between 1984 and 1986 of about 38 percent. That is significant.

As you rightly pointed out, this year's increase is very significant. It is $5 million, to be exact.

It is primarily aimed at the economics area characterized by development of analytical and methodological techniques that NSF has been addressing over the last couple years and will continue to address. It is a development of methodology and analytical techniques, and evaluation of them, and also in terms of looking at the computational facilities and data bases and data base analysis that is so important to this particular area.

So some of it is "instrumentation," included in here in this case, minicomputers primarily and construction of data bases. But it is primarily in the economics area and in the analytical economics area.

Mr. WALGREN. Let me ask a question on the policy level, also, raised by Mr. Brown. You indicated that your people provide support for OSTP and OMB. It is a little hard to get at OMB's influence in all of these decisions and who is ultimately weighing priorities when something comes out from OMB. It is quite a firm position within the administration by then. Therefore, it is difficult for agency heads to go over or to undo, or monitor, or to change. For instance, the role of OMB in setting the numbers in the supercomputer center area where, although you don't want to underfund supercomputer centers, OMB really, as I understand it, is limiting the numbers in a way that will define the numbers of centers we can immediately proceed with.

Was it your policy people who have the input at OMB or do they have their own people?

Mr. Bloch. Well, as you know, Mr. Chairman, what you are asking is really a very complex process between OMB and the Foundation.

Let me say one thing in general, and I am trying to be responsive to your particular question. We started off obviously with a much higher budget that we requested from OMB. In fact, what we started with was $1.7 billion. That didn't come about for good and valid reasons. So that is point number one.

Point No. 2, within the discussions with OMB, I have found—this is my first year, obviously—that OMB left me a lot of leeway in what I wanted to do and what I wanted to fund, in particular in the area to which you are referring, namely, the supercomputer centers.

In the $1.7 billion budget there, there was a higher number earmarked for that particular area for 1986. I think we had earmarked approximately $60 million—I'm not absolutely sure but somewhere around there. But I'll give you the right number.

[The information follows:]

The amount requested for Advanced Scientific Computing in the $1.7 billion NSF FY 1986 budget request to OMB was $61.8 million.

Mr. Bloch. When the bottom line came back, I decided to cut it back strictly because of balancing with other disciplines, with other activities and so forth. So that was my decision.

In that particular area, OMB left me a very free hand. I wish I would have had a free hand on the bottom line, also.

Mr. Walgren. But again, my interest is, what policy evaluations lie behind OMB's judgments to give you that bottom line that then resulted in other decisions that were made?

What sense can we have for their policy judgments?

Mr. Bloch. Well, let me say in response to that that I think the budget that we have—first of all, OMB has, with the exception of the Department of Defense, has essentially had one policy, which is a freeze, a freeze compared to 1985.

We were caught in that freeze. The NSF was caught in that particular freeze.

We did a little better than the freeze, as you can see. But internally we took it upon ourselves—and I think it is the right thing to do—to focus on the research areas and provide as many dollars to them as possible.

So I don't know if I can answer your question to your satisfaction but I think we got caught in the same thing that everybody else got caught in, and that was the freeze approach to life.

Mr. Walgren. Thank you.

Mr. Cobey?

Mr. Cobey. No questions.

Mr. Walgren. Mr. Bruce.

Mr. Boehlert.

Mr. Boehlert. Thank you, Mr. Chairman.

Mr. Bloch, before I get to two of my pets, one is supercomputers, second about the certification, I want to commend you for the emphasis in your statement on science education.

I am somewhat confused by the numbers as I look at this. If I recall correctly, during the last Congress we passed the emergency math, science, and foreign language studies bill, and according to my figures, you were given somewhere in the neighborhood of $115 million for implementation of that; yet, as I look in here, the numbers don't describe it at all.

Am I talking about two different areas of activity within NSF?

Mr. BLOCH. No, you are not. You are talking about the same area.

Mr. BOEHLERT. All right. What are we doing? What are you doing specifically to move with that? Because, as I look at this, as I look at this statement of yours, you are talking about a deferral from this year until next year.

I sort of had the impression that the emergency part of that bill indicated we better get moving and get moving in a hurry. Yet, it doesn't seem to be that we are experiencing the progress most of us would like to have seen.

Can you amplify on that a little bit, please?

Mr. BLOCH. Sure, I will be glad to amplify that.

You are right in observing that in this particular budget, 1986, you see essentially a $31 million deferral from 1985. Now, why? Let me make some general comments and I can specifically respond to this one.

This area, in the Foundation, has been in the process of being rebuilt. It was almost completely dismantled. That might be a slight exaggeration but not very much. A new assistant director was brought on board in the middle of last year in June. Dr. Shakhashiri was brought on to head up this very important directorate.

He has been building it up in the meantime and we are today at a point where we have between 40 and 50 people in this particular area. But it was a very slow process. This is point No. 1.

Point No. 2, equally important, we are very slow in moving on the sorting out of proposals that we are getting and approving them, because of what I said a moment ago. We had to bring new people on board and they had to become acquainted with this particular area; and also, the proposals themselves needed a lot of work if we wanted to put out quality proposals over the long haul.

So from all these considerations, buildup of a new directorate with new people, proposals that are coming in, and also the success to date in granting proposals, in the first quarter 1985, which is only 8 or 9 million dollars' worth, less than $10 million, we concluded we couldn't in good conscience and in keeping quality in mind spend the money in 1985 that was originally allocated.

You are right; it was $112 million. Your number is right. For that reason, plus the fact—and I want to be very forthright on that particular point because it certainly had something to do with it, with the limited budget requests that we had—our original request had more money in there than what this particular area is winding up with. It was a bottom line limitation that influenced the decision.

I decided the best thing that we could do would be to postpone and defer some of the expenditures, which we had a difficult time spending anyway, over to next year. At the same time, assure a level budget between 1985 and 1986 instead of the ups and downs that we had occurring in the past.

Mr. BOEHLERT. Comfort me, if you can. Can I be assured you are giving this matter priority attention?

Mr. BLOCH. I personally have spent probably more time on this directorate since I have been here than on any other directorate, yes.

Mr. BOEHLERT. How about the foreign language study aspect of that?

Mr. BLOCH. I am not aware that we have anything on the way on foreign language study but let me check on that and I will be back to you.

That doesn't ring a bell with me that that is part of our program.

Mr. BOEHLERT. We will talk more about that.

Mr. BLOCH. What we are talking about is science and mathematics education in precollege kind of areas. That is what we are focusing our effort on.

I will be back with you on the other one, if I may, if I am incorrect in my statement.

[The information follows:]

Under Title II of Public Law 98-377 (the Education for Economic Security Act), primary responsibility for providing financial assistance to improve instruction in foreign languages resides with the Department of Education. According to Section 212(d) of Title II, "In determining which languages are critical to national security, economic, and scientific needs, the Secretary of Education shall consult with the Secretary of State, and the Secretary of Defense, the Secretary of Health and Human Services, and the *Director of the National Science Foundation*. In keeping with this requirement, in December 1984 the Foundation responded to a request from the Secretary of Education to review a listing of critical foreign languages that was being prepared for publication.

Mr. BOEHLERT. Let's go back to supercomputers. Will there be consideration to geographic dispersion of those centers?

I wouldn't want to have all of them in New York, but——

Mr. BLOCH. The answer is yes. As part of the peer review process, we are focusing on geographic dispersion of an impact of what we are doing.

You should know that obviously, when we are looking at the center proposals, we are looking at a myriad of issues, the quality of the proposal, and what it can do for science. Let me assure you in the distributions I have seen as a result of the peer review, I think you will be satisfied that it is geographically dispersed.

Mr. BOEHLERT. During the peer review, will there be consideration given the national origin of the equipment?

Mr. BLOCH. You know, that has been asked before. In fact, we have been accused that we have looked at that.

Let me assure you that during the peer review process, the people that were involved in it did not look at origin of equipment as a very—as one of their problem areas or one of their parameters even. It was outside of their area. Obviously, I have to look at that myself.

There is one particular proposal that came in that has foreign equipment as a centerpiece of that particular proposal. It is not within the first three or four centers that I talked about before that we are funding, but it is pretty high up on the list, No. 5 or 6, in that particular area.

But foreign origin of equipment has not been essentially taken into consideration in the peer review ranking scheme, and I think it is kind of an academic question with the 1985 and 1986 dollars we have at our disposal right now. That question is kind of an academic question.

There are two sides to that coin, as you know very well, and I am very cognizant of the fact that the Congress last year when it first talked about supercomputers had not just the access to supercomputers and effect on research and researchers in mind, but also the fact that the United States, as I mentioned before, is in a competitive battle in this particular area.

Therefore, strengthening of our own industry in this particular area is very important. I am cognizant of that.

Mr. BOEHLERT. You have comforted me.

One last question: During the authorization bill last year, we added an amendment which I proposed which directed NSF to give priority consideration in funding R&D projects to those in the area of acid precipitation. Can you give me some insight as to what you are doing in that area?

Mr. BLOCH. No, I am afraid I can't, but I will be glad to supply it.

Mr. BOEHLERT. Please, because that is an area of major concern.

[The information follows:]

ACID RAIN—NSF SUPPORT OF RESEARCH RELATED TO ACID PRECIPITATION (FISCAL YEAR 1981–84)

[Dollars in thousands/number of projects]

Division	1981	1982	1983	1984	Total
Atmospheric sciences	$523/11	$238/10	$251/15	$350/19	$1,362
(NCAR-NSF)	(150)	(150)	(69)	(100)	(460)
Biotic systems and resources [BSR]	323/9	414/8	314/7	261/13	1,312
Chemistry		90/7			90
Earth sciences	283/3	103/2	141/4	9/1	536
Chemical and process engineering	(1)	(1)	68/3		68
Civil and environmental engineering	(1)	(1)	5/1	89/4	94
Materials research	(1)	(1)	51/5		51
Policy research and analysis	(1)	(1)	30/2		30
Ocean sciences	(1)	(1)	14/2	10/1	24
Total	1,129/23	845/27	874/39	719/38	3,567

[1] Not available.

Research tasks of NSF projects related to acid precipitation include: natural sources, manmade sources, atmospheric processes, deposition monitoring, aquatic effects, terrestrial effects, materials effects, control technology, and assessment.

In FY 1984 NSF research directorates supported projects amounting to $0.82M, representing a total of 38 new or continuing awards. Early in FY 1985 BSR renewed support of the Hubbard Brook Project in New Hampshire. NSF has supported this research for over 20 years. It was here that acid rain was first documented in the U.S. current activities center on continued trend monitoring, the role of natural or anthropogenic acidity and the role of acidity in the biogeochemistry of aluminum. NSF has been and intends to continue support of meritorious basic research in this area.

Mr. BOEHLERT. I have no more questions, Mr. Chairman.

Mr. WALGREN. Thank you, Mr. Boehlert.

Ms. Meyers.

Mrs. MEYERS. No questions.

Mr. WALGREN. Mr. Packard.

Mr. Nelson.

Mr. Slaughter.

Mr. SLAUGHTER. No questions.

Mr. WALGREN. Mr. Lujan.

Mr. LUJAN. I only have one. As you can well imagine, it is about the VLBA, Mr. Bloch.

I am concerned because we were looking at first the 3-year construction period and if we are talking about $45 million total cost and we allocate or appropriate $2 million in 1985 and what, $9 million in 1986, because of what I consider a very mischevious formula that you have to work with that was perhaps, many times we do things unintentionally here, but I doubt seriously that was unintentional, and that is my speech. But what are we looking forward to?

Are we looking at a 10-year period of building VLBA?

Mr. BLOCH. No, we are not looking at a 10-year period.

I'm glad you brought up this question. Let me put it in perspective, first of all.

In 1985, you are right, $9 million had been allocated to it and it was what we got through the authorization and appropriation process. We requested a bigger number from Congress than that and that delayed the program somewhat.

In 1986, in the budget you see, it is $9 million plus roughly $2.5 million or $11.5 million for 1986. That is not as high a number as we would have liked to see in 1986, but that is again my doing.

I mentioned that before, we looked to protect research first and the big capital investments we said come second in line, not that we wanted to cut them out; that is not the point. But we needed to reduce some of the big capital investments and VLBA happens to be a very big one. It is not the only one.

So we very deliberately in 1986 in submitting that particular request, which is less than what it would have been under our initial request that we submitted to OMB. But it was really in light of the fact that we have a constrained budget that we had to do some prioritization.

To answer your question, no, it is not a 10-year kind of a program, but instead of a 3-year program, it is a 5-year program, very definitely. So there is a delay.

Mr. LUJAN. But you have had all this money, you spent $2 million, you intend to spend more than that in the rest of fiscal year 1985?

Mr. BLOCH. We would have spent more than $9 million that we had allocated in 1985, yes, if we had had it, right. Is that your question?

Mr. LUJAN. You are going to spend the full $9 million in fiscal year 1985?

Mr. BLOCH. Absolutely.

Mr. LUJAN. And you intend to spend the $11.5?

Mr. BLOCH. In 1986.

Mr. LUJAN. In 1986.

Mr. BLOCH. But that is a slower rate for 1985 and 1986 than contemplated originally, and it is slower spending for 1986 than what we thought we could do in 1986 had we had a different kind of budget. That was my own decision.

Mr. LUJAN. Does it then have anything to do with the restrictions of money because of the amounts going for education? Does that have any correlation with your rate of spending?

Mr. BLOCH. In 1985, I think that you can draw that conclusion. The money diverted from VLBA was put in the education budget.

In 1986, we got a problem from a different kind of angle; we got it essentially from the angle of protect research, protect people, and stretch out capital expenditures.

So education directly had nothing to do with it but certainly it is the limitation of the budget as a total that had something to do with it.

Mr. LUJAN. Let me ask you a question which I don't fully understand, and it is not being critical, it is just a question.

This whole supercomputer initiative within NSF, could you tell me why that is necessary when in the past—and it is a very competitive industry certainly, we have depended on the private sector to be upgrading and making bigger machines and smaller machines as a matter of fact—why is it necessary that we involve the Federal Government in that?

Mr. BLOCH. Well, let me try to explain that.

First of all, if you look pre-1983, there were very few supercomputers installed in universities, maybe two, something like that. I could be off, but I am probably not off by 100 percent on that number.

The reason for it is very simple, that universities cannot afford that kind of an installation on their own.

Second, I think over the last couple, 3 years or maybe even 5 years by now, the realization of the various researchers in the various disciplines that we are interested in of the use of supercomputers is on a different level than it was before.

Supercomputers today play a different kind of role. That has to do with their capabilities. It has to do with the fact that the access to them, I mean the software is what I mean by access, is easier to accomplish. It is a more friendly environment and the problems that the researchers are dealing with are becoming more complex and therefore requiring this kind of a tool.

Also, in many areas, engineering areas in particular but not only engineering areas, the old ways of doing business, experimentation on the bench, are really being superseded by modeling, analysis and simulation, a new way of doing research and doing engineering.

Mr. LUJAN. I guess maybe I am off on a different tangent. You are talking about supplying equipment.

Mr. BLOCH. Right.

Mr. LUJAN. To universities, rather than computer—rather than research for upgrading computers.

Mr. BLOCH. That is exactly right.

Mr. LUJAN. You are talking about buying and installing equipment in the universities.

Mr. BLOCH. It is a tool, exactly.

Mr. LUJAN. OK.

Mr. BLOCH. But it is important to understand that supercomputers are coming into the mainstream of research whereas before they were not, they were in very isolated areas, like weather forecasting as one example.

Mr. LUJAN. Thank you.

Mr. WALGREN. Mr. Mineta.

Mr. MINETA. Thank you, Mr. Chairman. Thank you very much, Mr. Chairman.

Mr. Bloch, I would like to just follow up on the whole question of supercomputers. How many do you expect to fund after fiscal year 1986?

I think you mentioned earlier four or five, is it, and then fiscal year 1985 and 1986?

Mr. BLOCH. I mentioned three in 1985 and the fourth one which I was careful to label an experimental installation, and then with the one that we are getting from NASA, hopefully we can fund a fifth one; namely, using that particular machine, and therefore it will be kind of a low expenditure, at least the 1 year, in 1986.

That is what we can afford in 1985 and 1986. If you look beyond that, the first question that you have to ask is, how many of these centers do we need? You can get different numbers from different people.

Some people will tell you one per university. You know that is the wrong answer. Also, it is not three or four.

But I would think that we probably would be well advised over the next 5 years—and you have to look out that long—that we have something like half a dozen to a dozen centers in total. But that is a guess on my part.

Mr. MINETA. And how will networking be used to facilitate access to national computer centers?

Mr. BLOCH. How will networking be used, you are saying?

Mr. MINETA. Yes.

Mr. BLOCH. As you know, networking is in its infancy today. It is a technology that is making very, very rapid progress and I think what we have to understand and we are trying to understand today is, what is the need?

What kind of data rate do you need if you want to communicate between various centers? You've got to understand how often you do that and so forth.

So what I foresee is essentially a multilayered kind of a network. It probably will build very heavily on existing networks, existing university networks, the ARPANET happens to be one, CSNET is a second one and so forth.

We will tie into the existing networks first. But then hopefully over time, and that could be a 3- to 5-year time period, there will be a super network on top of these or replacing these that interlinks these centers in many different ways so that you have very fast data rate access to them, and also be able to handle very low-rate kind of lines.

So it would be that kind of a network. It won't be, that all of a sudden it is here. It will evolve over time, building on existing technology. As this new technology becomes available, hopefully you can integrate that.

Mr. MINETA. In looking at funding for these national supercomputer centers, to what extent is IBM compatibility an important consideration?

Mr. BLOCH. Well, I wish you wouldn't ask me that. But let me try to answer it.

Mr. MINETA. Since your're spending so much time in looking at this whole issue, as you were saying, this directorate has taken a great deal of your time in response to a question of my fine colleague, Mr. Boehlert.

Mr. BLOCH. I was talking about the education directorate.

Mr. MINETA. OK, I see.

Mr. BLOCH. The reason I say, I wish you wouldn't ask me that, I come from IBM so I might have a conflict of interest.

But let me be very factual with you.

Of the 21 proposals that we received, 3 of them were IBM compatible machines, 3 of the proposals were based on IBM compatible machines. One of the proposals used a Japanese machine as the centerpiece as I mentioned before; the other ones did not. It's kind of interesting. The others were essentially a combination of an IBM central processing unit together with Floating Point array processor, a large number of them. Floating Point is a small company out in the Midwest I think.

So you can judge for yourself. Apparently 18 proposals didn't think IBM compatibility was a very important subject, while 3 thought compatibility was important.

Mr. MINETA. Has that been taken into consideration by NSF in their planning considerations?

Mr. BLOCH. Not directly. Let me tell you what was—it was taken into consideration in an indirect way. Obviously we always are asking ourselves the question, and the committees that have worked on that and the people that have worked on it, the review committees that have worked on it, to what use are these computers? What kind of programs do these people have today, in what mode are they working today, what does it take to transfer these programs over to supercomputers. In that respect it has been taken into consideration.

Mr. MINETA. Given the importance of getting solid and innovative research going both in terms of scientific benefits and benefits of national scope, what is NSF's role in funding younger investigators, particularly women and minorities?

Mr. BLOCH. Well, first of all in general what I mentioned before, the Presidential young investigator grants are obviously aiming at the group that you are talking about.

With regard to women and minorities we have some shelter programs for both of these and they have been proven I think to be very important. They are trying to prepare minorities and women to be able to transfer into the mainstream of the NSF programs and only in this way will we ever get to the point where we have—where we are attracting and where we are fostering both women and minorities in science and technology.

But we have a number of programs that are addressing the women problem; we have a number of programs that are addressing the minority problem.

But we also hope that besides those, we not only hope we are watching it very carefully, what is the participation of minorities and women in our mainstream kind of programs because in the end that is the only—that is the only test that you want to put to it. That is the only important way of achieving equality, and attracting and retaining people.

Mr. MINETA. It seems to me that to be mainstreamed, that is essentially to be really walking or running in that arena, you have to start with a crawl and the Women in Science Program as I recall last year was something like a half-million dollars, this year 4 million, but we had some 440 or so proposals just in the Women in Science Program.

So if we expect them to be mainstreaming, and that is the bigger arena we want to encourage people to be in, we have to start somewhere. I am just wondering whether or not that million dollar pot—although it's doubling——

Mr. BLOCH. Doubling from last year, yes.

Mr. MINETA. Yes.

Mr. BLOCH. It's doubling from last year. I wish we could put more money into it.

Mr. MINETA. Over 440 proposals just for that $500,000.

Mr. BLOCH. You are absolutely right. But nevertheless we doubled it. We kept the visiting professorship for women, which is another aspect of it, on a slightly different level. We kept that one flat. And the minority research initiation one we kept that flat at $2.5 million, also. We have a total of about $12 million in the shelter kind of programs.

Mr. MINETA. One last question if I may, Mr. Chairman, and I ask your indulgence on this.

On page 13 of your statement, Mr. Bloch, you say that NSF has supported much of the early conceptual work in highly parallel computer architecture years before the relevance of that work to defense, energy, and other missions was recognized.

Then on page 7 you say that part of your effort at preparing for the fiscal year 1986 budget was that you had to curtail programs that are not in the mainstream of scientific and engineering research.

I am wondering if that isn't a conflict in the sense that we are trying to broaden our ability to do, to encourage new innovative ideas without prejudging where that might be taking us since that essentially is what page 13 is all about, yet on page 7 you are saying we had to curtail.

I am wondering if this isn't—if we are not doing something today where we are constricting things that might be essential programs a few years downstream?

Mr. BLOCH. Let me explain what I meant on page 7. Then I will let you judge yourself.

What page 7 really referred to in that curtailing of programs that are not in the mainstream are two items: first of all the areas which are really not in the mainstream of science and technology, and Mr. Brown before focused on one of the activities that we curtailed, namely the policy research and analysis. That is point No. 1.

Point No. 2 we went very vigorously through all the programs in all of the directorates and we reduced or zeroed-out programs that were of lesser kind of priority than the ones that we had. These were programs that had been in existence for some time and you could see where the results had been achieved or where you could essentially say that the results that you are going to achieve from here on in are marginal at best and not necessarily unknown kinds of areas or areas that are so far out that you cannot judge them today.

So I think we did a very careful job in analyzing the base.

It's really out of the base that we curtailed and reduced programs.

But that doesn't mean that one can't overlook something, you are absolutely right there, but I hope that we did a decent job and very careful job in that regard.

I don't think anything like the parallel processors area of 5 years ago fell by the wayside here, at least I don't think that was the case. You can never be absolutely sure, as you know very well.

Mr. MINETA. I would hope that your crystal ball is very clear.

Mr. BLOCH. No, it's not.

Mr. MINETA. Thank you very much, Mr. Bloch.

Thank you, Mr. Chairman.

Mr. BLOCH. Thank you.

Mr. WALGREN. Mr. Henry.

Mr. Smith.

Mr. SMITH. Mr. Bloch, when I came in you were in conversation here with the chairman on the budget, and, if the question has been answered, then pardon me. But, if in fact the 4.5-percent increase—roughly that is in the President's budget—for some reason were not granted, if it were frozen, there is a great deal of sentiment or fast rising sentiment in the Congress today for an across-the-board freeze. Should that happen, what specifically, if you had to make the decisions, what specifically would be lost to NSF?

Mr. BLOCH. Well, I——

Mr. WALGREN. I hate to put you in that position.

Mr. BLOCH. That is all right. I hope that is an academic question, or will turn out to be an academic question.

But, obviously, the budget that we have is a very, very balanced kind of a budget. We tried to be responsive to the demands that are on us and to the opportunities that we have.

It's very difficult to say where I would take 4 percent out, to be very honest with you.

I certainly wouldn't spread it 4 percent across the board. I can tell you that right now. I don't think we can afford that kind of nickel and diming and that is what it would be, nickel and diming.

I probably would single out areas that are of lesser importance to us, or again do similar things that we had to do already, stretch out certain investments, stretch them out even further and I would probably go after capital investments again including maybe VLBA or something like that, but I would certainly look at that area first to see how much we can stretch out, look at areas to see if we can do with less even though it might not be a full kind of a program but I would like to protect the very important initiatives that we have been starting and that need investment on a continuous kind of basis because they are just coming up.

I probably wouldn't take it out of supercomputers. Probably wouldn't take it out of engineering research centers and probably not out of instrumentation even though it might very well be tempting to do that.

So I would say I don't know how I would do it but I would not do it at 4 percent across the board, and I don't think that is a responsive way and responsible way of doing it. So it would be stretchouts of capital investments, cutting back on certain things and so forth but trying to protect the areas that are getting off the ground and that need fostering and that are important for the productivity of the Nation and that are important to all of us.

Mr. SMITH. Thank you.

No further questions, Mr. Chairman.

Mr. WALGREN. The Chair would recognize Mr. Boehlert for a second turn.

Mr. BOEHLERT. Let me say to you, I certainly hope you don't experience any freeze problems. To put things in perspective, let me give you a little ammunition. Your entire budget requested with a 4.4-percent increase is less than the revenue that is going to be lost to the U.S. Treasury come October 1 when the excise tax on cigarettes goes from 16 cents to 8 cents a pack.

Mr. BLOCH. Thank you very much.

Mr. BOEHLERT. Use that, I advise you.

Mr. BLOCH. As a nonsmoker, I will use it.

Mr. BOEHLERT. I am a smoker and I hate to admit it, but use it to your advantage.

Let me ask a further question. I asked this of Dr. Keyworth, and I would like to ask you. You expressed great concern in your testimony about the declining percentage of U.S. citizens going into engineering and science graduate studies. It's a concern we all share. But before they get to graduate school, they have to go to undergraduate school, and, maybe I'm backing you into a corner on this one, but do you share my concern of the decline in commitment evidenced in this budget for student assistance programs?

Mr. BLOCH. Well, that gets into a different area which NSF really is not involved in.

Mr. BOEHLERT. I understand that, but I wish you would comment.

Mr. BLOCH. But I think we have to make sure that it does not get interpreted in that particular way, that it's a turnoff for some of our young people to choose an academic career and also to choose a science and engineering kind of a career.

I am no expert on that particular area and I am lucky that I have nothing to do with that particular program, I guess, but I would hope that one can put that in a different kind of perspective and that some of the misuses of that probably leading to that kind of reaction, and maybe one could get away from the misuse of things we will be in better shape. I don't know. I am backing off somewhat from your question as you can see.

Mr. BOEHLERT. In addition to being a fine engineer and administrator, you are also a very effective diplomat. Thank you. No further questions.

Mr. BLOCH. Thank you.

Mr. WALGREN. Mr. Bloch, on behalf of the committee I would like to thank you for coming. I would like to compliment you on the level of your testimony. I would like to underscore the appreciation of the people in this capacity for your being open about your judgments and what you are weighing as alternatives, because ultimately we have to try to evaluate the recommendations you have made and we have to be able to make similar judgments and to know the reasons why you have chosen the emphases that you have.

So I really do want to express my appreciation for the level of your testimony and the candor of it in the judgmental area.

Thank you very much and we look forward to talking with you in real detail about these various areas in the near future.

Mr. BLOCH. Thank you very much.

[Whereupon, at 3:20 p.m., the committee was adjourned, subject to the call of the Chair.]

1986 NATIONAL SCIENCE FOUNDATION AUTHORIZATION

WEDNESDAY, FEBRUARY 20, 1985

House of Representatives,
Committee on Science and Technology,
Subcommittee on Science, Research and Technology,
Washington, DC.

The subcommittee met, pursuant to notice, at 1:38 p.m., in room 2318, Rayburn House Office Building, Hon. Doug Walgren (chairman of the subcommittee) presiding.

Present: Representatives Walgren, Brown, Wirth, Boehlert, Ritter, Henry, and Cobey.

Mr. Walgren. Let us begin. Today the Subcommittee on Science, Research and Technology begins two hearings on the fiscal year 1986 budget request for the National Science Foundation. The purpose of the hearings is to hear the views of individuals, in the first instance, that are outside the Foundation, on the overall direction and priorities that are reflected in the 1986 budget request as submitted to the Congress.

We are very pleased and grateful to you gentlemen and other witnesses that will make the effort to give us their views. It's very helpful in the process, and we certainly appreciate the time and the discipline that you put into that.

The budget request for the National Science Foundation indicates a total authorization level of $1.56 billion, which is an increase over the previous year of $11.8 million or something in the range of 4.4 percent. Within this total budget there is a $1.39 billion allocation for research and related activities, representing a 7 percent increase over fiscal 1985, an $82 million allocation for science and engineering education, a $120 million allocation for Antarctic research, and a $1 million allocation for their special foreign-currency account.

We are pleased to see that the new initiatives that the Director of the National Science Foundation has given emphasis to have been expanded, primarily in the areas of the engineering research centers, biotechnology, and advanced scientific computing.

The subcommittee has had a longstanding interest in issues related to science and engineering education, in particular. We are particularly concerned about the slow pace of the Foundation's reestablishment of the science and engineering education directorate, and are interested in the allocation of the $31 million in unobligated funds that is carried forward from the past several years. And we certainly will look forward to evidence and views given on the progress in science and engineering education by a number of our witnesses, and I know that you are very involved in that area and will be good sources to rely on.

The list of witnesses for today's hearing includes Dr. Robert White, president of the National Academy of Engineering; Dr. David Hamburg, president of the American Association for the Advancement of Science; Dr. Robert Rosenzweig, president of the Association of American Universities; Dr. Guyford Stever, the president of Universities Research Association and chairman of the Natoinal Science Foundation's task force on international strategy and programs.

Accompanying them as witnesses today is also John Sloane, vice president for engineering of the Aluminum Company of America.

And at some point in the process we are going to be looking forward to Congressman Bob Edgar, who represents an area in Philadelphia and has been involved in encouraging some initiatives in Pennsylvania.

I want to welcome the witnesses to the subcommittee and again thank you for the time and the effort you have put into preparing your views for us.

I would like to give other members on the subcommittee an opportunity to welcome you if they have opening remarks of any kind. If not, then we will just go directly to Dr. White.

I want to ask unanimous consent of the members that photographs be allowed to be taken during today's hearing, and without objection, that will be the order.

Well, let's start with Dr. White. And if we can structure our presentations somewhere in the range of 10 minutes or thereabouts, we will have time to talk a little bit afterwards and explore your views.

Dr. White, please proceed.

[A biographical sketch of Dr. White follows:]

ROBERT M. WHITE

President
National Academy
of Engineering

Dr. Robert M. White, President of the National Academy of Engineering, was born in Boston, Massachusetts in 1923 and took his university degrees at Harvard and MIT. His undergraduate work at Harvard was in geology and his graduate work at MIT, after a four-year stint in the Army Air Corps during World War II, was in geophysical fluid dynamics, applied to the atmosphere. He left MIT in 1950 for a highly productive decade in research on problems of atmospheric prediction and global atmospheric and ocean dynamics at the Air Force Cambridge Research Center.

NAE's President is recognized not only as a significant contributor to his field of science and technology, but also as an institutional innovator. He was a co-founder of the Travelers Research Center, Inc., a non-profit subsidiary of the Travelers Insurance Company in Hartford, Connecticut, in 1959. It was one of the first corporations in the private sector to embark on a program of research and services in the environmental sciences. The corporation served private industry, federal, and state governments. At Travelers, Dr. White led a major effort for the FAA in the design and development of automated systems for observing, communicating, and forecasting weather.

His work at Travelers led to his appointment by President John F. Kennedy as Chief of the U.S. Weather Bureau in 1963. Over the next 15 years, Dr. White was appointed to a succession of Presidential posts of increasingly greater responsibility. He served under five Presidents, (Kennedy, Johnson, Nixon, Ford, and Carter) in important governmental posts. These years led to his involvement and interest in a wide range of science and technology policy issues. Under Presidents Kennedy and Johnson, he undertook the restructuring of the Weather Bureau and fostered the introduction of new technologies of weather observation, communications, and processing. He led the Weather Bureau in the establishment of the first operational earth orbiting meteorological satellites. Today these satellites are the backbone of the global meteorological observation system. He fostered the introduction of new technologies of high speed communications and display systems to improve the responsiveness of the daily operations of the weather service. He was a leader in the institutional restructuring of environmental sciences and services in government. In 1965, Dr. White and others convinced President Lyndon Johnson to bring together the Weather Bureau, the Coast and Geodetic Survey and part of the National Bureau of Standards into a new Environmental Sciences and Services Administration.

In 1968, he was appointed to the President's Commission on Marine Science, Engineering, and Resources chaired by Dr. Julius A. Stratton, then President of MIT. This Commission led to the formation of the National Oceanic and Atmospheric Administration (NOAA) under President Nixon. Dr. White was appointed its first Administrator. NOAA was to be the center strength in the federal government for oceanic and atmospheric affairs. It brought together activities as diverse as the Bureau of Commercial Fisheries, the National Sea Grant Program, Naval Oceanographic Instrumentation Center, the Coast and Geodetic Survey, and the U.S. Weather Bureau. The task of welding these diverse elements into the formidable agency it has since become, was successfully completed under his leadership.

In the early 1970's the Congress enacted an extensive body of new environmental legislation and broadened NOAA's responsibilities to include the administration of The Fishery Conservation and Management Act of 1976 and the Coastal Zone Management Act, Marine Mammal Protection Act, and the Marine Sanctuaries Act, thus confronting the new agency with difficult policy issues of balancing environmental values and economic development. As part of these new responsibilities, Dr. White was appointed the U.S. Commissioner to the International Whaling Commission, and there led the fight to protect the great whales.

For NOAA and its predecessor organizations, international collaboration was a way of life and Dr. White was involved in many of them. He was the Permanent Representative of the United States to the World Meteorological Organization of the United Nations for 15 years. He was a key figure in the development of the World Weather Watch and the Global Atmospheric Research Programs which saw the deployment of new satellite and communications technology on a worldwide basis. He was the chief negotiator for the United States in the development of bilateral agreements, for example, with the Soviet Union under President Nixon for the exploration of the world's oceans, and with France on oceanography. He stimulated the development of the FAMOUS Program (French American Mid Ocean Undersea Survey) in which manned civil submersibles from the United States and France descended 12,000 ft. to explore the Mid Atlantic Ridge.

Upon leaving the government in 1977, Dr. White joined the National Research Council and in 1979 became its Administrator. On a part-time basis he was asked by the oceanographic institutions of the United States to organize a new university consortium called the Joint Oceanographic Institutions, Inc. to plan and oversee the nation's deep sea drilling program carried out aboard the "Glomar Challenger." As Administrator of the National Research Council, Dr. White was instrumental in leading the effort to establish the new National Academy Press as a means of improving the publication system of the Council.

In 1980, he assumed the presidency of the University Corporation for Atmospheric Research (UCAR), a consortium of 50 U.S. and Canadian universities which operates the National Center for Atmospheric Research (NCAR) in Boulder, Colorado and the National Scientific Balloon Facility in Palestine, Texas. At the same time, he was appointed Chairman of the Commission on Natural Resources overseeing a wide range of the NRC's activities in the field of energy, agriculture, minerals and the environment, and subsequently, Co-Chairman of the Commission on Physical Sciences, Mathematics and Resources.

Dr. White continues to be active in an advisory capacity to the United States government. He is a member of the Advisory Committee on Science and Technology to the Department of State and until recently, was a member of the National Advisory Committee on Oceans and Atmosphere (NACOA), a Presidential Commission with oversight of oceanic and atmospheric affairs in the U.S. government.

He has retained an active role in academic affairs. He has had extensive involvement with the university community as President of UCAR. He has been a member of the Board of Overseers of Harvard University. Presently, he is a member of the Harvard University Visiting Committee to the Division of Applied Sciences.

Dr. White is a member of the Board of Directors of Resources for the Future, Inc. in Washington, D.C., the Draper Laboratories in Cambridge, Massachusetts, and is a member of the Council on Foreign Relations, New York, New York.

Dr. White has been honored for his scientific work as well as his other contributions. He was elected to the National Academy of Engineering in 1968. He was the recipient of the Jesse L. Rosenberger Medal of the University of Chicago in 1971, the Rockefeller Public Service Award for Natural Resources in 1974, the Matthew Fontaine Maury Award for Contribution to Undersea Exploration of the Smithsonian Institution in 1976, and the International Conservation Award of the U.S. Wildlife Federation in 1977. Dr. White was also the recipient of the prestigious International Meteorological Organization Prize of the World Meteorological Organization in 1980. In 1984, he was awarded the Delmer S. Fahrney Medal by the Franklin Institute for outstanding leadership in science and technology. He is a Chevalier de la Legion d'Honneur of France. His work has been recognized by honorary doctorates from Johns Hopkins University, the University of Wisconsin at Milwaukee, Rensselaer Polytechnic Institute, and Long Island University. He has been President of the American Meteorological Society and Vice President of the Marine Technology Society.

Dr. White lives in Bethesda, Maryland with his wife, Mavis. He has two children. His son Richard is an economist in Washington, D.C. and his daughter Edwina a business executive living in Manhattan.

STATEMENT OF DR. ROBERT M. WHITE, PRESIDENT, NATIONAL ACADEMY OF ENGINEERING

Dr. WHITE. Mr. Chairman and members of the committee, I welcome the opportunity to appear before you to comment on the fiscal year budget proposal of the National Science Foundation. I will comment principally on the engineering aspects of the NSF fiscal year 1986 budget.

Our Nation faces an unprecedented challenge to its technological leadership and industrial competitiveness. It is important, therefore, that the NSF proposals be viewed not only through the prism of science and the contribution that the effort can make to the improved understanding of natural processes, but also through the prism of engineering and technology and the contribution they can make to our industrial competitiveness.

The reason that this is a vital dimension in our consideration of the NSF budget is evidenced by the attention that has been called to this issue in the President's State of the Union Message; the issuance of the report of the President's Commission on Industrial Competitiveness, entitled "Global Competition: The New Reality"; and the testimony given before the Science and Technology Committee by George A. Keyworth, the President's science adviser. And only yesterday, as if to mark the importance of engineering and technology in our national life, the President awarded the first National Technology Medal.

The National Academy of Engineering has also adopted as the major theme for its work over the next decade the advancement of the Nation's industrial competitiveness and its technological leadership. And as part of that effort, the National Academy of Engineering will release this evening the latest in its series of reports on the competitive status of various U.S. industries; in this case, the competitive status of the aviation industry.

While we all recognize that the advancement of this country's industrial competitiveness depends on many factors extending far beyond the realms of science and engineering, embracing fundamental questions of national economic policy, it is nevertheless generally recognized that at the core lies the national ability to be preeminent in science and engineering.

The mission of the National Science Foundation to support basic scientific and engineering research and education in our universities therefore makes its programs central to the long-term competitiveness of this Nation because our technological edge depends upon the availability of the highest quality scientific and engineering talent.

It is in this light that I urge the support of the President's fiscal year 1986 budget. The National Science Foundation seeks an increase over its fiscal year 1985 budget of approximately $100 million, about 6 percent. This is a modest overall increase and one that, in my view, is essential to the vigor of the scientific and engineering enterprise in the university community in this country.

The committee has asked that I comment on some of the engineering aspects of the National Science Foundation budget, and I would like to focus the remainder of my comments on them. The proposed budget for engineering represents an increase from fiscal year 1985 to 1986 of 13 percent from the $150 million to $170 million. This is the largest increase for any of the activities of the National Science Foundation. It is a most welcome action. It continues the strengthening of the engineering activities of the NSF begun some 2 years ago, and represents a recognition of the growing importance of engineering research and education in maintaining the technological leadership of the Nation.

I should indicate, however, that the total funding for engineering within the National Science Foundation remains just a small fraction of its total effort and has increased from only 10 percent of the total NSF activities in fiscal year 1985 to 10.6 percent in fiscal year 1986.

The increasing recognition by its leadership of the importance of engineering in the NSF has been accompanied by fresh approaches to address issues in new and innovative ways that deserve the support of this committee. For example, the engineering directorate has been moving to restructure its activities to address new classes of problems. It is restructuring them to deal with a number of cross-disciplinary engineering activities and to develop closer links between universities and industry while maintaining support for established fields of engineering.

In reviewing the budget, I was pleased to note the increased support being given to the new engineering research centers, initiated last year. The increase of $15 million to a total of $25 million in fiscal year 1986 is an important step in signaling the seriousness with which the program is being pursued.

This is a substantial increase when compared with other areas of engineering and other programs in the National Science Foundation. It represents a determination on the part of the National Science Foundation to support this innovative approach to cross-disciplinary engineering research, providing experimental capabilities not available to individual investigators, and a focus for research on engineering systems such as manufacturing, materials processing, and communications. It addresses the education and training of students and the improvement in the interaction between industry and the universities.

The NSF budget proposals are noteworthy in the additional support it provides to emerging and critical fields of engineering. Research in the process of engineering design, systems integration, automation, and emerging technologies such as biotechnology, deserve the committee's support. These emerging fields of engineering are planned for a 12.6-percent increase in fiscal year 1986 over fiscal year 1985. Among the areas that are planned for increased support is application of computers in engineering. Computers are revolutionizing processes of engineering design and manufacturing. They provide new tools which are transforming design theory and methodology in all fields of engineering. Typical of the promising new approaches in the NSF budget is an attempt to increase support for emerging fields such as light wave technology.

The plans of the Foundation to provide increased support for Presidential Young Investigators in engineering, bringing the total to 250, is an important step forward in providing research support to young faculty members and enticing them to remain within the academic community.

Ultimately, the purpose of the support for engineering research in the university community is not only to reap the benefits of new knowledge that results from engineering research, but also to support the education and training of new talent to meet national needs.

Our technological edge depends upon the availability of individuals of high quality trained to perform at the cutting edge of engineering systems knowledge. In the past few years we have had a dramatic increase in the undergraduate enrollments in engineering schools. The young people of this Nation are taking to engineering. They are among the brightest students entering universities, as evidenced by standing in high school classes and SAT scores.

We now have a remarkable opportunity for increasing the population of U.S. students at the graduate and doctoral levels in engineering in our universities. We should seize this opportunity because we have experienced a serious decline in the number of Ph.D. candidates in engineering schools. Today we are graduating only about 3,000 engineering Ph.D.'s. About one-half of these are foreign nationals.

While it is important for the United States to offer education and training in engineering to students from other countries, many of whom remain here, we need to make a stronger effort to encourage U.S. students to pursue engineering education through the Ph.D. level. The very large and excellent group of undergraduate students provides us with an opportunity to do so. While there is a slight increase in the support for graduate students in engineering of about 3.5 percent, my feeling is that this is inadequate to meet the needs for engineering talent at the cutting edge.

Last, I would like to comment briefly on the issue of instrumentation and equipment. It has been widely noted that the research needs in both science and engineering for instrumentation and equipment far outpace that which is available. In engineering research it is increasingly necessary for universities to have access to very expensive instrumentation and equipment if forefront research is to be conducted and if the students are to be trained in the research which is dependent upon the availability of such instrumentation.

A recent survey by the National Science Foundation completed last December on academic research equipment revealed that 90 percent of the university departments surveyed reported an inability to conduct critical experiments due to lack of needed equipment. Only 16 percent of equipment and instrumentation systems in the 1982 national stock in the various fields that were surveyed were classified as state-of-the-art.

General undercapitalization of equipment and instrumentation is a most serious problem and a problem that is not the responsibility of the National Science Foundation alone. For fiscal year 1986, an increase in equipment and instrumentation to support engineering research of approximately 20 percent is planned. This is encouraging. However, my feeling is that the problem needs to be examined more broadly and a national approach to the undercapitalization problem is urgent.

To summarize, it is my view that the fiscal year 1986 budget for the National Science Foundation is sound. It moves the support for engineering research ahead significantly. The approaches of the National Science Foundation to its engineering research responsibilities are new and innovative. The programs being proposed warrant the full support of this committee.

Thank you, Mr. Chairman. I would be delighted to answer any questions.

Mr. WALGREN. Thank you, Dr. White. We appreciate that statement.

Let's go to the other members on the panel and then come back for discussion as a group. We will turn now to Dr. Hamburg.

[A biographical sketch of Dr. Hamburg follows:]

BIOGRAPHICAL SUMMARY

David A. Hamburg

David A. Hamburg (health science policy), 1925; A.B., 1944, and M.D., 1947, Indiana University. Director, Division of Health Policy Research and Education, Harvard University, since 1980. Previously with Michael Reese Hospital, Yale University School of Medicine, Brooke Army Hospital, Walter Reed Army Institute of Research, National Institute of Mental Health, Stanford University School of Medicine, California Institute of Technology, and National Academy of Sciences (president, Institute of Medicine). Fellow, Center for Advanced Study in the Behavioral Sciences, 1957–58 and 1967–68; President's Medal for Advancement of Biomedical Research, Michael Reese Medical Center, and research prize, International Society for Research on Aggression, 1974; Phi Beta Kappa national lecturer, 1975–76; Menninger Award, American College of Physicians, and Bicentennial Medal, Massachusetts Institute of Technology, 1976; Vestermark Award, American Psychiatric Association, 1977; Rosenhaus Award, American Public Health Association, 1978; Distinguished Leadership Award, U.S. Department of Health and Human Services, 1980; president, Association for Research in Nervous and Mental Disease, 1967–68, International Society for Research on Aggression, 1976–78, and Academy of Behavioral Medicine Research, 1979. Current activities: Editorial Boards, *Psychosomatic Medicine*, *Behavioral Science*, *Aggressive Behavior*, and other journals; associate editor, *Journal of Psychiatric Research*; Advisory Committee on Medical Research, World Health Organization; Board of Governors, Tel-Aviv University; Boards of Trustees, Rockefeller University, Carnegie Corporation, and Leakey Foundation; Council, American Academy of Arts and Sciences; Committee on International Security and Arms Control, National Research Council. AAAS activities: AAAS-ABA National Conference of Lawyers and Scientists, 1977–; Board of Directors and Council, 1981–, Newcomb Cleveland Prize Selection Committee, 1981.

STATEMENT OF DR. DAVID A. HAMBURG, PRESIDENT, AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Dr. HAMBURG. Thank you, Mr. Chairman, members of the subcommittee. I appreciate the privilege of meeting with you today. The subcommittee has a distinguished record both as a tough investigator and also as a strong supporter of scientific and engineering research and education.

The AAAS is the umbrella organization of American science. It continues to be involved with a whole range of science and technology in this country and indeed to a large extent in other countries as well. It publishes the journals Science and Science 1985 and tries in various ways to relate the scientific community to the Federal Government, among other tasks.

I am submitting a rather extensive statement which I hope will be helpful, but will condense it drastically for this purpose. The statement covers an overview of R&D nationally and in the Federal Government. It covers key international comparisons in science and technology. It covers science, technology, and the economy, science policy, and, of course, the NSF budget.

Mr. WALGREN. Let me say, if I might, that written statements will be made part of the record and reproduced in full so that now what you prepare on paper will be incorporated in the record and be there for reference so that you can select and emphasize in whatever way you feel is most effective to underline the points that you want to make. Thank you.

Dr. HAMBURG. Thank you, Mr. Chairman. I appreciate that.

To begin just very briefly with a rather prescient set of remarks that President Truman made in 1945, just 3 weeks after the war's end. He said:

> Progress in scientific research and development is an indispensable condition to the future welfare and security of the nation. No nation can maintain a position of leadership in the world of today unless it develops to the full its scientific and technological resources. No government adequately meets its responsibilities unless it generously and intelligently supports the work of science in universities, industry, and in its own laboratories.

It's hard to realize that was 40 years ago. It might have been yesterday. And it is the central rationale for Federal support of science of Presidents who followed Truman, up to and including President Reagan, and who have worked with the Congress in building strong Federal backing for research and development.

But sometimes the question arises why the public should support research and development at all. First and quite obviously, there is the R&D that has to be done to support the special responsibilities of Government: Defense, public health, the environment, and so on. But there is more than that. A second and related major reason for the special role of the Federal Government in R&D arises from the very risky nature of R&D investments. One simply cannot be sure that any one research effort, no matter how brilliant the leadership, will pay off. But probabilities of success are a lot greater when the aggregate of R&D projects is large and when alternative paths are enlarged.

To take a concrete and vivid example, Nazi Germany chose one path, a blind alley, in its search for a nuclear weapon, while the

United States achieved success by following several paths on a large scale, in effect as insurance.

We see the Federal role in providing the scientific underpinning for communication satellites and computers as two examples where the Government took the lead, where initial risks were high, technologies were uncertain. And also we see that there was not long-term Federal domination once the base was provided. The commercial applications were and are plentiful.

A look at the Federal R&D budget for fiscal year 1986 compared to 1985 shows big increases in defense R&D, decreases, though slight, in nondefense R&D, and virtually flat basic research. A great increase, dramatic increase, in defense. On the nondefense side, there is a 1-percent slippage in absolute dollars. And if you take into account, say, a 4-percent rate of inflation, which seems conservative, then the decline in nondefense R&D becomes more significant. Total basic research is virtually flat, but again a significant decline in constant dollars assuming a 4-percent inflation rate.

One of the major factors in the basic research problem is the OMB action with respect to the National Institutes of Health. It is a real problem. There is no time to pursue it here. But in effect, OMB is spreading the money appropriated by the Congress last year over a longer time, thus diminishing the funds available for the current year's budget. And it has an impact on basic research because, in fact, the HHS is the largest supporter by far of basic research in our Nation.

Now, the amount of U.S. investment in R&D has been and remains large. It looks good in comparison to other countries in many respects. But there are problems that key international comparisons suggest. In the context of Dr. White's remark about industrial international competitiveness, we have to look at the international comparisons, and they are developed in our full statement.

Now, the nondefense spending has, by and large, been going down for a long time in real purchasing power. In the 1981-86 period all nondefense agencies of Government have experienced real reductions in their R&D budgets, and in those 5 years some have been seriously hurt, like the Alcohol, Drug Abuse, and Mental Health Administration. Those are very important responsibilities and very inadequate R&D budgets.

So that once one disaggregates what is generally speaking an encouraging science budget, there are real problems embedded in it. Not to cry alarm, but as an antidote to complacency, briefly, if we look ahead some years, we should keep in mind what we need to consider. First, if defense and space R&D continue to increase their shares of the total Federal R&D budget, it will be difficult to support other nondefense R&D even at current levels. Second, as one looks ahead to the growing family of very large scale technological commitments, such as the space station and SDI, the squeeze on available R&D resources could become severe.

Finally, it's not unreasonable to be apprehensive about substantial displacement impacts on resources for general science. There might be severe displacement effects if a large proportion of scientists and engineers are drawn away from university-based research which provides such a fundamental source of creativity drawn into defense work. There are positive sides to that; there are tradeoffs.

But we need to keep an eye on it as it evolves over the years ahead.

Now a word about the economy. Maintaining our scientific and engineering strength with appropriate balance—I emphasize balance—between defense and nondefense R&D is going to be central in the years ahead to powering our economy as well as providing for our national security. There is a great deal of economic and other social science analysis which indicates that scientific and technological advances or, in short, the growth of knowledge, have been a major source of economic growth in this country and in other countries both in the short term and in the long term since this kind of work began, which was really around the time of the great economic depression.

Now a word on international science and technology. It's been very important that the U.S. scientific community, which is so large and for a long time was the largest—and I think it's probably not chauvinistic to say the most highly respected scientific and technical community in the world—that community has been deeply engaged all along on the world scene. The scientific community is probably the closest approximation we have indeed to an international community of any kind, and U.S. scientists and engineers have been heavily involved as individuals and in international scientific groups and governmental bodies. It's been a tenet both of scientific outlook and of U.S. foreign policy that we ought to foster that kind of active participation.

If anything, the importance of that is greater today than it was when President Truman spoke 40 years ago because the world is more compact, it's more interrelated, more intimately connected, and we are aware that the problems of the world and the opportunities are in many respects global. It's a matter of plain self-interest to be very much on top of the world scene, have our windows wide open to see what's going on in other countries, which have plenty of creativity, and to address ourselves to the problems that other countries have, particularly the developing countries.

Now, I regret to say that there has been some slippage overall in these matters, and I commend to you as people who clearly care about American leadership in world science as well as American contributions to the general well-being, we should take a keen interest in this problem.

For one thing, the terrible famine in Africa ought to be a stimulus to us to think about a change in economic development strategy, in which there would be a large role for United States-African scientific cooperation, or more broadly, U.S.-developing country scientific cooperation, so that they can develop the capability to address their own problems effectively and not forever be in a dependent kind of situation.

AAAS is working on this. There is a major role for the U.S. scientific community beyond what is now being done.

A quick word about East-West relations in science and technology. There is some thaw occurring, and we believe that thaw ought to be facilitated. One aspect is the support for the International Institute for Applied Systems Analysis in Austria, IIASA, created primarily by the United States and the Soviet Union some years ago, an international scientific organization doing generally useful and valuable work, bringing together established scientists and young scientists from a number of countries.

The AAAS has recently joined in a consortium of nongovernmental scientific associations to support the work of IIASA, and we would urge you to consider recognizing the importance of IIASA both to the advancement of international science and to U.S. national interests, by authorizing institutional support—not just project support for which they're eligible now, but institutional support—at a level of approximately $1 million a year, which was about one-third of the former level before that support was knocked out altogether a few years ago. It ought to come back now, at least in a modest but dependable way.

The second point is about United States-Soviet relations. In June 1984 it was my privilege to sit next to President Reagan when he gave an important address in which he endorsed scientific and scholarly exchanges with the Soviet Union. He called for a revival; he announced that he was authorizing renewed cooperation under the existing agreements and that the agencies responsible should develop more active programs. And there has been, since last June, some modest but real progress, thanks to the stimulus that the President gave to that program. There is a considerable distance to go, and I ask this subcommittee to explore with the administration the reinstatement of the bilateral S&T agreement as part of a constructive and forward-looking move in improving United States-Soviet relations.

That brings me to a word on scientific communication and national security issues. The great political and economic freedom which we have in this country has been an extremely important stimulus for our scientific and technological community. That's one reason why we're so far ahead of the Russians and all other closed societies.

But there are delicate problems involved of national security in the international climate which exists. I want to commend the role the NSF has played in trying to address these problems, especially to clarify the responsibility of U.S. scientists under the Export Administration regulations, EAR. Achieving the proper balance between legitimate national security interests and those related to freedom of scientific communication requires a fine sense of judgment.

The NSF has made a good proposal, and it has been approved by an OSTP advisory committee, and I hope it will be adopted by the Department of Commerce quickly so that the chilling effect of the current EAR language on scientific communication can be overcome. Again, this is a matter on which this committee can take a serious interest, the balance here between the necessary freedom for science to flourish and the necessary restrictions for national security.

The science policy study of the parent committee, I just want to commend the committee. The AAAS believes this is a remarkable undertaking, to have a long-range overview. We are in this country so often beset by preoccupation with kind of the short-term bottom line, and here you are taking a long-range overview which we think could be a model for others in undertaking a comprehensive inquiry that would lead to better policy formulation.

You will have a lot to read, but I commend to your attention, and submit with your permission, Mr. Chairman, an article by President Donald Kennedy of Stanford University, which appeared in a recent issue of our journal Science, that states some of the key issues, some of which were touched on by Dr. White a moment ago.

[The article referred to follows:]

Government Policies and the Cost of Doing Research

Donald Kennedy

Summary. The changes in the political economy of science are the natural outcome of two trends: science itself has become a more capital-intensive activity at the same time that federal support for research programs has slowed its growth. The results of the accumulating shortfall in the capital base for university research—increased seeking of support from private industry, efforts to circumvent peer review and competitive allocation, and a falling-out between institutions and investigators over how to divide up available resources—threaten to unravel what has been an extraordinary way of doing science.

The political economy of science is a subject that did not need very much attention during the decades following World War II. We developed a wonderful system for doing science through a series of events mostly set into motion at the end of the war. At that time, vigorous public-sector support for fundamental research was guaranteed when a large military apparatus for research was converted, with remarkable suddenness, into one of the largest plowshares ever made.

Two important principles became attached to that great experiment. The first was the commitment to peer review as a method of determining what scientific programs should get public funding. The second was the decision that, for publicly supported fundamental research, the universities provided the best environment. The government could have taken quite a different course; it could have established a set of quasi-independent laboratories for which it sought cooperative support with the industrial sector, like the Max Planck Institutes in Germany; or it could have created a large array of government laboratories. That it did neither guaranteed that new discovery and the training of the next generation of discoverers would take place in the same locations, thus establishing one of the great strengths of American science. That strength is well recognized in Europe; at the 1977 Nobel awards, when Americans swept the prizes for the first time, our thoughtful Swedish colleague Suny Bergstrom pondered the phenomenon and finally attributed it to the "democracy of American science" (*1*). He meant the fellowship of the bench—the system of apprenticeship that is built upon the coexistence of research with research training.

The success of that experiment hardly needs elaboration here. Instead, I will concentrate on some strange symptoms that have been emerging in the past several years, and then make an effort to understand their etiology. Here are the symptoms.

- Georgetown University appeals to Congress for Department of Defense funding for a $160-million coal gasification fuel cell cogeneration program that will include construction of a power plant on the Georgetown campus. This is but one of several projects earmarked for specific universities that are taken directly to Congress, bypassing the competitive agency review process. The president of the Association of American Universities accuses Georgetown of "going by the law of the political jungle" (*2*).
- The National Institutes of Health (NIH) propose to withhold 10 percent of indirect cost reimbursement due the universities in the budget year 1983, citing recent increases in the proportion of indirect costs as a percent of total research costs. The House Appropriations Committee then adds report language to the NIH appropriation, increasing the total amount of NIH funding and instructing it to reimburse the full value of allowable indirect costs (*3*).
- The National Academy of Sciences Council passes a resolution noting that proper review systems "have contributed to the scientific preeminence of the United States," and urging "that the academic community and public officials exercise vigilance to protect this informed evaluation and decision-making process in the awarding of funds, not only for the support of scientific research proposals, but also for major scientific facilities and instrumentation" (*4*).
- The Federation of American Societies for Experimental Biology accuses university administrators of playing a "four-dimensional shell game" with indirect costs and describes them as having made a "triumphant tour de force in evading the issue in the past 3 years" (*5*).
- Hoechst AG and Massachusetts General Hospital sign an agreement whereby Hoechst supplies $67,300,000 for facilities construction and program costs for research on molecular biology (*6*).

What in the world is going on here? Can these things be related, and if so, to what underlying cause? Is our understanding of how to do science coming apart? Has the glue vanished from our traditional concept of what is the responsibility of industry, of government, and of the universities?

I do not think so. But I do think that our kind of science is crossing a significant watershed. It is hard to know exactly where to locate the divide, but the terrain contains an important transition from people to property, and from operating to capital budgets—at which point we must start worrying more about one-time equipment costs and facilities renewal than we do about salaries. On the maps, the territory on the other side of the divide is labeled Big Science.

The Advent of Big Science

Over the past decade, a number of disciplines have crossed over: organic chemistry, various parts of solid-state physics, and molecular biology. The rest of cell and developmental biology is well on its way. In the 1960's, the main problem for department heads in making appointments had to do with billets: that is, with persuading the dean and the provost that the growth potential of our discipline justified the retention of an additional faculty position. A decade later, an interesting transition occurred. Although we still worried about billets, the

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main problem became whether we could commit the equipment and space renovations necessary for the new appointee to do the work. The capital cost of the equipment and special facilities, in short, had become larger than the capital value of the endowment necessary to yield the faculty member's salary. That is as good a definition as any of Big Science. It immediately raises the most serious questions of resource allocation—for example, do we need to consider new patterns of sharing, even between different institutions? Thus we now find ourselves engaged with the very questions that have preoccupied high energy physics since the 1950's.

That would not be very difficult for the scientific enterprise if we still faced the same economy and the same policies that obtained when we began our exploration of this new territory. Through most of the 1960's, federal support of basic science was adequate to handle both the operating-budget side and the modest capital demands associated with most scientific work. Toward the end of the 1960's, two things happened. First, we witnessed the end of federal support for the construction of research facilities. Second, with respect to equipment, the situation has been even worse. The rising demand for more and more sophisticated instrumentation has confronted a declining federal commitment to pay for expensive capital equipment. The expanding consequent shortfall has been documented in the 1980 instrumentation survey conducted by the Association of American Universities for the National Science Foundation (7).

That survey served as the basis for a request in 1980 by the Carter Administration for a special $150-million appropriation to the National Science Foundation for research equipment, which would have been a down payment on a total liability that was estimated to be $1 billion (8). The item was stricken in the revised budget request by the Reagan Administration, and no adequate effort to deal with the problem has been mounted in the intervening 4 years. In fiscal year 1984 the total federal investment in R&D plant in universities is projected at $40 million (9). Thus, although there has been modest real growth in federal operating budgets for research and development during the past few years, the capital gap has been widening for much longer than that.

There is something very predictable, indeed almost implacable, about the behavior of an unfunded liability—and science is a vigorous and thoughtful activity that instinctively senses its own needs very well. Therefore, I argue that the political spasms that we are now seeing result from the struggles of the scientific venture to escape the prison of its own undercapitalization.

Politics and Scarcity

Before discussing the events themselves, let me briefly sketch the motivations and the behavior of the different players: Executive government, Congress, the universities, and the scientists themselves. All are in agreement on some basics: the importance of science, the essential desirability of seeing it supported effectively, and the need to divert resources to the best work. But each group has particular responsibilities, needs, and political roles—so the behaviors differ.

Executive government is accountable, eventually to the voters, for effective programs. Most government agency budgets distinguish poorly between one-time capital expenditures and "budget-base" monies; there is thus an unhealthy incentive to avoid the former in order to make one's own annual budget request look better and support the kind of fiscal responsibility to which American voters are increasingly sensitive. To such agencies, and to Congress as well, scientists are an important constituency, and university administrations much less so. The rules for this are fairly simple. First, more abundant economic units usually have greater weight in the political process: that is why associations of automobile dealers wield more influence than associations of automobile manufacturers. Second, working scientists are much more fully and effectively integrated into administrative and policy processes in the research agencies. Yet, despite their relative lack of influence, it is the universities rather than today's scientists that have the greater long-term interest in the quality of capital facilities as opposed to operating expenses.

That, then, is the background: a capital deprivation of some 16 years' duration, begun at about the same time that federal support for research programs slowed its growth and fell onto an uneasy, variable plateau. And in the meantime, the scale and the obligations of the scientific venture continued to grow. We now find ourselves caught in a mismatch between the needs and expectations of scientific research, on the one hand, and the willingness and capacity of the public sector to support it, on the other.

The results are predictable. Whenever resources are scarce, their allocation becomes a matter of desperate controversy, and alternatives previously unconsidered begin to claim attention.

The symptoms that I highlighted above and that have captured the attention of the media reflect three manifestations of the current crunch. The first is an increased attentiveness, on the part of the universities and investigators alike, to private sources of funds as a substitute for federal ones. The second is a disturbing incipient collapse of the agreement between the performers and sponsors of research, that peer review is the fairest and most effective way of awarding scarce resources. The third—and it is the most distressing of all—is a falling-out between the proprietors and the doers of scientific work over how the research venture is to be supported.

Private Funding for Research

The interest in private sources of funds strikes me as more reassuring than troubling. It was inevitable that universities would turn more to commercial sources of support as government began to flag; and it is equally inevitable that proprietary organizations would, in the new style of venture capital, begin to try to assert possession of ideas at an earlier time in their evolutionary history. That has meant a refocusing of commercial interest upon more basic, as opposed to merely applied, research, and this, in turn, has produced some problems.

The most serious involve the division of energy and effort of faculty members between their own university laboratories and small proprietary ventures in which they have an equity interest. Significant disputes over intellectual property and substantive conflicts of interest with respect to the independence and well-being of graduate students and fellows have both emerged. One can only hope that most of them have been fairly resolved, but we are gaining a grip on the problems, and a sensible pattern of accountability should eventually emerge.

In general, the larger scale arrangements between universities and industry consortiums or major single firms have offered far fewer difficulties. Over the years, the universities' standards for crafting such broad, formal agreements have been pretty thoroughly tested by government, and thus most of the prospective problems have been solved in advance. Just in case universities were tempted to forget those principles, the government gave them a sharp reminder on openness of research just as many of the new industry agreements were coming along. Efforts to apply arms export control regulations to fundamental research reminded us that freedom of exchange and openness of publication are important attributes of fundamental science. Admiral Bobby Inman's warning that the universities should not keep secrets for profit that they would not keep for patriotism was probably unnecessary; but it did usefully emphasize the point, and at just the right time (*10*).

Despite the public fuss about increased industry sponsorship of basic research, something less than 5 percent of university research is actually now supported by industry, and that fraction is growing only imperceptibly. The appearance of a few special arrangements in areas of particular commercial interest is not a harbinger of wholesale substitution of private for public dollars in the support of fundamental research. Indeed, a drop of 1 percent in the federal support of university science requires a 20 percent increase in industry support to make up for it—distinctly unfavorable leverage. A general private rescue from public obligation is clearly not in sight.

Peer Review

The second phenomenon—the incipient dismantling of part of the peer review system—is more surprising. It has always been true that occasionally a university or a state has been awarded a particular research facility by a friendly congressman; and of course a special kind of regional allocation has always been present in the agricultural sector. Recently we have witnessed an unparalleled spasm of noncompetitive set-asides for special facilities in particular places. They involve not just the Georgetown case (now not included in the Department of Energy request for 1985), but also such diverse institutions as the University of Oregon Health Sciences Center, Catholic University, Florida State University, and Columbia University (2). In fact, Columbia and Catholic probably started the present round 2 years ago, by engaging a Washington lobbying firm to intervene on their behalf in adding special facilities for chemistry and vitreous-state materials, respectively, to the Department of Energy budget (*2*). They were successful, and that has led others to try as well. The growing epidemic is the more surprising because of the unanimous approbation that we thought adhered to the processes of peer review and competitive allocation. It is as though three or four civilized nations had decided, all at once, to return to whaling.

A dangerous prospect, of course, is that each defection increases the sense, on the part of those who retain commitment to the consensus, that there will soon be nothing left. (In that respect, too, one is reminded of the international control of whaling.) Although the Association of American Universities and the National Academy of Sciences have both deplored these departures from the convention (*11*), the smell of pork, or is it whale meat, may prove too tempting. The optimists are hoping the problem goes away and the pessimists are getting to know their congressional representatives.

Indirect Costs of Research

The last of the three embodiments of scarcity is, as I have said, the most troubling. It has already had harsh political ramifications, ones that have been felt on the campuses as well as in Washington. It is especially deplorable because it pits friend against friend, and threatens to unravel the basic fabric of understanding and trust that has supported our science for 30 years. I am referring, of course, to indirect costs.

The fraction of total research costs that go to pay indirect costs, or overhead, has increased steadily over the past decade. The increase has been quite modest for some government agencies—National Science Foundation, for example; but it has been steeper in others, like NIH.

For years, government policy has held indirect costs to be an entirely legitimate part of total research costs. These costs cannot be allocated easily to particular projects: they include the operation and maintenance of buildings; departmental, general, and research grant administration; depreciation or use charges on facilities and equipment; student services; and libraries. They are calculated according to an often-reviewed system developed by the Office of Management and Budget and set out in OMB Circular A-21 (*12*). Basically, the rules require that cost pools be created for each category; the proportions of total costs in each category attributable to instruction and to research are then calculated. The ratios are used to ensure that indirect costs are charged to the government only when they are associated with research-related activities or other sponsored agreements. Thus, for example, only those costs of the library associated with organized research are spread over government-sponsored research projects and only the consumption of heat and power associated with research activities can be charged to government-sponsored research. The total of such indirect costs allocated to research is then divided by the total of modified direct research costs to yield the rate. The formulas have been revised repeatedly and reviewed by independent accounting firms (*13*). The details may perhaps stir disagreement, but I think most would probably conclude that the rules are fair.

How, then, can the proportion of indirect costs as a fraction of all research costs be increasing? There are several reasons.

1) Inflation affects some cost items, (such as energy), much more than others. To the extent that these items are research-intensive and are paid through the indirect rather than the direct route, there will be a disproportionate increase in indirect costs.

2) Cost-accounting studies done by universities on research have been steadily refined and improved, largely at the urging of the government. Increasingly, therefore, they have identified and captured costs to which the universities have always been legally entitled. In the early days of indirect costs, everyone was underrecovering. Many state universities still are because in these institutions reimbursement flows to the state treasury, and the universities lack the incentive to expend resources on the documentation needed for full recovery. A corollary is that indirect costs vary widely among different kinds of institutions. This variance does not indicate that the whole thing is irrational; on the contrary, it is yet another instance of the rational power of economic incentive (*14*).

3) Changes in research volume and the adequacy of direct support put additional pressures on indirect costs. Reductions in the rate of growth of government funding have caused a saturation of research volume in many institutions. Those indirect costs that are fixed must then be spread over a relatively smaller number of direct-cost dollars, and the rate rises. In addition, NIH in particular has recently pursued a strategy of underfunding in order to maximize the number of grants it can award. Investigators, universities, and Congress have tried to discourage this practice. This year, in spite of the substantial NIH budget restorations and in spite of explicit Appropriations Committee language, one institute made across-the-board cuts in all grants (*15*). Since a large proportion of indirect costs are fixed, underfunding of

the direct costs will cause the proportion of indirect costs to rise. These effects of volume are often magnified by the government's rules about reimbursement. The difference between the negotiated rate and the actual rate appears after the fact; when unexpectedly low volume, for example, produces an actual rate that is higher than expected, the difference may be collected by an increase in the rate for succeeding years. On this basis, many research universities have accumulated large carry-forward costs during the present period of volume saturation, and this provides an advancing wave of upward pressure on the indirect cost rate.

4) Over half of the indirect costs of research are associated with facilities, and among those one of the significant contributing costs is depreciation or use allowance on capital equipment and buildings. These cannot be recovered by universities, of course, if the government has financed the building or purchased the equipment; that would be collecting twice. As long as the government was financing most of the buildings and essentially all the equipment, this was a minor element in recovery. During the 1970's, however, the government essentially stopped supporting construction of research facilities. At the same time, it became increasingly common for major pieces of equipment to be supplied to the institution from private sources, and this trend accelerated as the tax laws were changed to give more favorable treatment to equipment donations by manufacturers. For example, between 1968—the last year of the Health Research Facilities Act—and 1983 Stanford's indirect cost recovery rate practically doubled. The annualized growth rate for sponsored research over that period was about 6.5 percent. For the administrative components of indirect costs, it was about 9.5 percent. But for the depreciation and use charges, it was 11.5 percent.

Indeed, an examination of the inflation rates for various categories of indirect cost over the past decade bears out the extraordinary significance of facilities—and the relatively lower impact of those administrative categories so frequently blamed for the effect. The annualized rate of inflation of modified total direct research costs at Stanford was 1.18 percent higher than the Bay Area consumer price index for the period 1974 through 1983. Reflecting their general relative increase, indirect costs grew at 4.34 percent on the same basis over the same period. But if the indirect costs are broken down into their component pools, the aggregate of building-related costs (operations and maintenance, equipment, depreciation, and use charges) is revealed to have an annualized growth rate of 8.41 percent, whereas administrative costs (general, departmental, sponsored projects, and student services) have grown at only 0.30 percent per year (*16*).

Despite these straightforward explanations for the phenomenon of increased indirect costs, NIH has, for two consecutive years, attempted to withhold 10 percent of already-incurred indirect cost recovery from the universities, but so far Congress has denied that effort.

The worst thing about the NIH strategy is not that it would have depleted the general funds of the universities, although that is true, but that it has produced extraordinary divisions between principal investigators and university administrators. The administrators do, after all, have an obligation to preserve both the operating and the capital prospects for original scholarship, as well as to make sure that the general fund is healthy enough to support salary improvement and other worthy purposes. For a private research university like Stanford, indirect cost recovery from the government is characteristically the second most important income source, behind tuition but well ahead of all endowment income. If it shrinks, then either something else on the income side has to swell (and almost nothing can), or something on the expenditure side has to shrink; it is that simple. Thus, it ought to be in any faculty member's best interest to support fair reimbursement for indirect costs. To date, administrators have not done a very good job, either of persuading faculty that some of the functions supported by indirect costs are well run or explaining the economics and the policy that underlie indirect cost recovery. In consequence, when NIH proposes to principal investigators to increase the number of grants at the expense of indirect cost recovery to the university, it sounds like a bargain, even though it is anything but.

It is not surprising that the indirect cost matter has stirred controversy between scientists and their university administrations. Some principal investigators took the position that more money could be put into their own research activities if the universities' reimbursement was cut. Others, who saw the relation between legitimate recovery and the payment of such expenses as faculty salaries, were not so enchanted. But nearly all were troubled.

Like many controversies, however, this one has had some unexpected and salutary outcomes. An informed coalition of university associations and scientific groups helped in obtaining full funding for both direct and indirect costs in this year's budget. That coalition accomplished the replacement of the $75 million in indirect costs that NIH had attempted to withhold, and also restored about $140 million in direct costs. From the success, we learned that squabbling over categories of research costs is not only divisive, but self-defeating. The Federation of American Societies for Experimental Biology has also reversed its position on indirect costs and passed a resolution calling for cooperation between university administrators and bench scientists.

It is not, however, part of the bargain for the universities stubbornly to insist that all is right with the indirect cost picture. The problem needs a broad reexamination on a government-wide basis, led out of the Office of Science and Technology Policy. The result of such a study, which is under way now and in which university associations and scientific organizations are both participating, may well be some limitations upon one or more categories of indirect costs. That may be acceptable, especially if there is some trade-off relief from accountability documentation or other administrative requirements that would give universities real cost reductions and not just loss of recovery. What is not acceptable is an arbitrary action by one piece of the government that attempts to divide the academic community.

Conclusion

I have tried to suggest that the sea change in science policy, evidence of which is all around us, is a natural outcome of two evolutionary trends. The first is of our science itself, to a more and more capital-intensive activity. The second is an accumulating shortfall in the capital base for university science, resulting from a failure of the public patrons of science to acknowledge the importance of that kind of investment. That shortfall has produced, or at least exacerbated, a number of events: increased seeking for private industry support by universities; heavier temptations to circumvent the ordinary processes of peer review and competitive allocation; and squabbles over how to divide up, between institutions and investigators, the pool of resources available to support scientific work. Indeed, the indirect cost problem itself is in part a consequence of chronic undercapitalization.

The squabbles and the policy challenges will be more easily resolved if we understand their origin. In addition, we must focus our attention on the problem of institutional capacity and the health of capital resources. In comparison with what is available elsewhere, and what ought to be available to us, our environments are significantly worse then they were a quarter century ago. We owe to the next generation of students and faculty members an opportunity to do science as close to the forefront as all of us have been able to do it. Commitments only to the number of research grants next year, or to the total programmatic support of research in the federal budget, will not make that happen. It will only perpetuate the present liability, extend the divisions between researchers and institutions, and blunt the promise that our extraordinary way of doing science has created.

References and Notes

1. S. Bergstrom, opening address at the 1976 Nobel Festival, reprinted in *Inst. Med. Newsl.* (February 1977), pp. 3–4.
2. L. Feinberg, "Colleges bypass agencies to get federal funds," Washington *Post*, 5 June 1984, p. A-6.
3. House Committee on Appropriations, *Department of Labor, Health and Human Services and Education, and Related Agencies Appropriations Bill, 1983*, 97th Cong., 2nd sess., 29 September 1982, H. Rep. 894, p. 26.
4. "Statement of the Council on Federal Funding for Research Facilities and Instrumentation" (National Academy of Sciences, Washington, D.C., 30 October 1983).
5. *Fed. Am. Soc. Exp. Biol. Newsl.* **16**, 2 (March 1983).
6. Agreement between the General Hospital Corporations and Hoechst AG, 13 May 1981.
7. Association of American Universities, "The scientific instrumentation needs of research universities," a report to the National Science Foundation, June 1980.
8. The Carter Administration responded by requesting, as part of its fiscal year 1982 budget request, an additional $75-million appropriation to NSF for research equipment. This funding would have been only a small "down payment" on total liability estimated at over $1 billion ["Special analyses, budget of the United States Government, fiscal year 1982" (Office of Management and Budget, Washington, D.C., 1982), p. 314].
9. "Federal funds for research and development, fiscal years 1982, 1983, 1984" (NSF 83-319, Division of Science Resource Studies, National Science Foundation, Washington, D.C., 1983), vol. 32, p. 121.
10. B. R. Inman, *Aviat. Week Space Technol.* **116**, 10 (8 February 1982).
11. B. Schorr, "Breaking tradition, more colleges go directly to Congress for funds," *Wall Street Journal*, 5 March 1984, p. 29.
12. For a review of the rules and requirements of recovery of indirect costs, see Ad Hoc Committee on Government-University Relationships in Support of Science, "Strengthening the government-university partnership in science" (National Academy Press, Washington, D.C., 1983), chapter 6, pp. 117–145.
13. The most recent such review was conducted by the San Francisco accounting firm of Peat, Marwick, and Mitchell in 1977.
14. As would be expected, the variance is markedly reduced when only similar institutions are considered. In addition to the important distinction between public and private, there are expected differences in rate between medical schools and other research areas, and between large- and small-volume performers. If one considers only those research universities that are (i) private, (ii) have medical schools and include them in the rate, and (iii) have large research contributions from both medical and nonmedical components, the following indirect cost rates may be compared for fiscal year 1984: University of Chicago, 69.0; Columbia University, 69.7; University of Pennsylvania, 65.0; Stanford University, 69.0; and Yale University, 68.0.
15. The underfunding strategy is disclosed in a letter from W. F. Raub, deputy director for extramural research and training at the National Institutes of Health, to A. Merritt, director of the Office of Research Administration at the University of Pennsylvania, in February 1984. Raub states, "While most Institutes are making only 1 to 2 percent reductions, the National Institute for Arthritis, Diabetes, and Digestive and Kidney Disease has found it necessary to make a larger reduction to fund its proportion of the approximately 5000 grants that the National Institutes of Health will be awarding in FY 1985."
16. These growth rate measurements were made from audited Stanford data on the actual indirect cost pools. Similar figures for the cost allocations would differ less, because in the process of arriving at the latter, each cost category is subject to proportional cross-allocations from the others. Thus, for example, general administration receives a cross-allocation from the operations and maintenance pool, so that it will include the costs of maintaining and heating space used for that activity. The effect of this cross-allocation will be to "load" the purely administrative costs with the more rapidly inflating building-related costs. The indirect cost pools themselves are uncontaminated by this effect.

With respect to the NSF budget, it's not possible to go into any detail. In general, we commend the administration for adhering to the course of recent years of strongly supporting increases in the research programs of the Foundation and of basic research in the Nation generally.

We are, however, deeply concerned about science and engineering education, thus the strong involvement of the AAAS and also of the foundation I head, Carnegie Corp. We feel this is a critical and, unfortunately, a neglected area. Starting in 1980 we had this rash of reports. We sort of rediscovered education in the United States, and particularly science education. One report after another has come out—generally good reports—and particularly the report of the National Science Board, in my judgment, an outstanding report.

But that clarion call for action, originating as it did in, you might say, the family of the NSF, has not been followed with the notable vigor on the part of the NSF that one would wish. I understand they have a very difficult problem. The Science Education Directorate was virtually destroyed a few years ago, not because of any NSF initiative. It's much easier to destroy than to rebuild. They're in the process of putting it back together. But it is going very slowly.

For the past few years NSF has not spent a large part of the money made available to it by the Congress. Nobody is suggesting they throw the money at problems. There are lots of specific and useful things to be done, and have been done. There are also some new ideas, some new technologies that could be very important in science education. And Congress is obviously troubled by this situation. As far as we're aware, no contract has been set in place to follow up on the congressional mandate of last year, and it's unknown when the plan will emerge.

I know that Director Bloch, who is a very distinguished man, wants to address this problem. I think you can help him, and you may want to have this on your oversight agenda.

That's my deepest concern about the NSF situation. I have some concern about the NSF international science and engineering programs. I don't think they fared very well in the budget. I see a disparity between the rhetoric and the budget.

With respect to women, minorities, and the handicapped, Mr. Bloch has done very good things, and the National Science Board has done very good things. Nevertheless, there are real reasons to be concerned: an absence of programs at the college level for women and minorities in science and engineering education; a significant underfunding of the research opportunities for women program; and some others.

The fact we have to recognize is it's just not only a matter of equity, important as that is, it is a matter of national security. That is to say, the cohorts of young people coming along to be scientists and engineers and physicians and what have you is a smaller and smaller cohort over the next couple of decades, and a larger and larger proportion of that cohort consists of women and minorities. Women have traditionally had some difficulties with math and science; they've been told they're not so good at that sort of thing, which is not correct. Minorities have had even more serious problems. And in the national interest we simply have to make full use of the talent pool, the great talent pool which we have, which includes a lot of women and minorities who could perfectly well do science and science-based professions. We have to make that possible.

A final word about a small part of the NSF budget, but a very significant one, in the scientific community and the Nation at large, and that's the program on ethics and values in science and technology. It's a little piece of the big budget. Evidently, there's an intention to knock it out. We feel very strongly it should not be knocked out. It has represented a symbolic commitment by the NSF to the principle that scholarly research has a lot to contribute to understanding contemporary controversies involving science and technology, that we shouldn't leave those controversies to polemics, to slogans, to anecdotes. They ought to be analyzed systematically and scientifically to the extent possible. We are not in the scientific community just advocating any old use of technology, we are looking toward a judicious use of technology. We are aware that there are dangers as well as benefits with the technologies that we can create.

Dr. White's academy and his leadership has set up a series on technology in society to examine very frankly the problems as well as the benefits associated with rapid, unprecedentedly rapid technological change.

So we're entering new terrain with our rapid scientific advances, and we've got to consider the ethical dilemmas of matters which EVIST was considering; for example, food safety decisionmaking; for example, trade secrecy in patents; for example, animal research in biomedical and behavioral science; human gene therapy; risk taking in the introduction of new technology.

Those are hardly trivial subjects, and it is simply not right for the scientific community to walk away, and NSF has got to provide a focus for that kind of work.

A final word on the social, economic, and behavioral sciences. It was a disaster in the first year of this administration, the onslaught which led to drastic cuts. It was a mistake. It's been recognized as a mistake. Dr. Keyworth and others have been trying seriously to rebuild, and we congratulate them for that effort. There is a healthy increase. But mind you, we're not yet back to the 1980 level. We're making fine increases from a terribly low baseline. The increases are not as strong in the behavioral sciences—for example, psychology—as in the economic sciences. But it's moving in the right direction.

But I ask you what is more important in the world today than a deeper understanding of conflict resolution? Similarly, we've seen come out of the Institute of Medicine of the National Academy of Sciences in the last few years major studies on health and behavior, the importance of behavior like cigarette smoking and alcohol use and drug abuse in our Nation's health. The No. 1 burden of illness relates to behavior, and that is a call for a conjunction of behavioral and biomedical sciences, cooperation between NSF and NIH. So one wants to monitor the continuing growth of support for the behavioral sciences.

Well, overall there is very much in the science policy and science budget at the present time to be hopeful about, much that's fascinating, much we can feel encouraged about. But it's prudent that we avoid complacency and seek a really never-ending improvement in the crucial science base of modern life.

Thank you, Mr. Chairman.

[The prepared statement of Dr. Hamburg follows:]

Statement by

Dr. David A. Hamburg

President

American Association for the Advancement of Science

on

The Fiscal Year 1986 National Science Foundation

Budget Authorization

Before the

Subcommittee on Science, Research and Technology

Committee on Science and Technology

U.S. House of Representatives

Rayburn House Office Building

February 20, 1985

Mr. Chairman and Members of the Subcommittee:

INTRODUCTION

Thank you for the opportunity of appearing before you today as part of your hearings on the National Science Foundation budget request for Fiscal Year 1986. This subcommittee has a distinguished record both as a tough investigator and strong supporter of scientific and engineering research and education and it is a personal privilege for me to be here with you.

In beginning my statement, first let me say just a few words about the American Association for the Advancement of Science -- or the AAAS as it is commonly known — of which I am the currently-elected President. Our members are about 136,000 scientists and engineers; as affiliates we have 285 other scientific, engineering and technical societies and organizations -- with a total membership of around five million.

AAAS publishes the journals Science and Science 85, the latter being a a high-quality general science magazine written for the interested layperson. Finally, the Association also is active in a broad variety of activities in public policy and public understanding of science and technology.

STATEMENT OUTLINE

Today I shall comment on a number of topics which provide a general setting for considering the NSF's budget request. Here is my roadmap.

- Overview of research and development -- nationally and in the Federal Government
- Key international comparisons in science and technology
- Science, technology and the economy
- International science and technology
- Science Policy
- NSF commentary
- Summary

OVERVIEW OF RESEARCH AND DEVELOPMENT

By any measure the United States invests large sums of money in research and development; the national total for 1984 -- public and private -- is estimated to be about $98 billion. For the past several years this total has been increasing at a rate of about 11 percent per year so it is probably not a bad guess that the 1985 total will be something around $109 billion. Yet, as I will show later, numbers alone do not tell a complete story.

For the past four decades, the United States has supported substantial investments in research and development. These investments have been made for much the same reasons that President Truman stated before a Joint Session of the Congress on September 6, 1945, only three weeks after war's end, when he said:

> Progress in scientific research and development is an indispensable condition to the future welfare and security of the Nation. No nation can maintain a position of leadership in the world of today unless it develops to the full its scientific and technological resources. No government adequately meets its responsibilities unless it generously and intelligently supports the work of science in universities, industry and in its own laboratories.

Presidents who followed Truman -- Democrat and Republican alike up to and including President Reagan -- have worked with the Congress during their Administrations in building strong Federal backing for research and development. This backing has taken the form of establishing science-and-technology-based organizations, providing budget growth and taking a wide range of actions in science and engineering education, patent, tax and anti-trust areas.

The private sector -- including industry, the universities and non-profit organizations -- has likewise responded to the challenges identified by President Truman. Appendix 1 shows how the relative shares of Federal and non-Federal support of national R&D have varied over past decades and how the total in current and constant dollars has changed during the same period. After declining as a proportion of the national total in the 1950s, the non-Federal share has risen steadily since 1960. Beginning in 1977, the non-Federal and Federal shares became equal at fifty percent each. By 1979 the non-Federal share had inched ahead and gradually increased to a 54-46 percent margin which has held for the past four years.

Why Should the Public Support Research and Development?

This is a policy question more frequently discussed in terms of a specific R&D program or area; however, since there are a number of new Members on the Subcommittee I hope you will not mind if I briefly re-state the general case for public support of research and development. First, and quite obviously there is the R&D which must be done to support the special needs of government -- e.g., defense, public health, environment, etc.

Less obviously, the overall benefits to the nation of much -- but not all -- long-range R&D often exceed the benefits to the organization that pays for it. Thus, competitors can benefit from corporate R&D investments by using the new knowledge generated to their own benefit. And since consumers may also benefit from lower prices and improved quality, the benefits of successful R&D may not necessarily lead just to increased corporate profits.

Further, corporations must properly consider profitability strategies and avoid what might be considered excessive R&D expenditures or R&D work that is not obviously connected to principal business interests. All in all, this leads many to conclude over time that there has been and will continue to be underinvestment by the private sector in R&D -- and particularly in basic research. This line of thinking leads to the argument for public sector support of Federal R&D as a major component of a total national effort in R&D -- particularly in basic research.

A second, and related, major reason for the special role of the Federal Government in R&D arises from the highly risky nature of R&D investments. One cannot be sure that any one research effort, or any small group of such efforts, will pay off. For example, in the new product development area the private sector faces odds in which only two or three of every one hundred innovative ideas becomes successful in the market place.

Comparable problems of riskiness exist in the governmental arena. However, probabilities of success are greatly enhanced when the aggregate of R&D projects and alternative paths is enlarged. In one of the critical technical and political decisions of this century, Nazi Germany chose one path -- a blind alley -- in its search for a nuclear weapon while the U.S. achieved success by following several parallel paths as insurance.

The upshot is that private investment in R&D -- particularly of a long-term, uncertain payoff nature -- are frequently discouraged by high risk considerations. Communications satellites and computers are but two examples of the Federal Government taking the lead where initial risks were high, technologies were uncertain, and markets were in uncharted waters. However, both sets of industries also clearly demonstrate that Federal leadership does not imply long-term Federal domination.

All of this leads to a clear conclusion that Federal support of R&D has been and will continue to be an important investment in the future. The overall benefits appear to be large -- and as will be discussed in later sections, the economic and technological benefits have worldwide significance. Generally, we believe that research and development should be supported strictly on the merits as a long-term investment.

A Look at Total Federal R&D for Fiscal Year 1986 Compared to 1985 Shows Big Increases in Defense R&D, Decreases in Non-Defense R&D, and Virtually Flat Basic Research

First, to clarify nomenclature, all of my references to FY 1986 budget numbers and comparisons are in terms of budget authority. Among the key observations are these:

- Conduct of R&D is up from $50.4 billion in FY 1985 to $58.2 billion in FY 1986. This is an overall increase of 15.5 percent.

- The big increase, of course, is in defense. Department of Defense military R&D is up from $32.1 to $40.1 billion, an increase of $8 billion or 24.8 percent.

- On the non-defense side, the story is much different. Total non-defense R&D slips slightly in FY 1986, from $18.2 billion to $18.1 billion, a decline of about 1 percent.

  NOTE: These figures have not been adjusted for anticipated inflation. If one assumes a 4 percent rate of inflation (about what the Administration seems to be forecasting), the decline in non-defense R&D becomes more significant.

- Much of the decline in non-defense R&D results from these cutbacks:

- (-5.7 percent)	Department of Health and Human Services
- (-2.6 percent)	Department of Energy
- (-6.1 percent)	Department of Agriculture
- (-18.6 percent)	Department of Transportation
- (-26.0 percent)	Department of Commerce -- especially the National Oceanic and Atmospheric Administration
- Various	Other smaller agencies

  NOTE: Funds were appropriated by the Congress for FY 1985 which would have permitted NIH to make 6500 grant awards. However, the Administration proposes to hold the number of awards to about 5,000 in both years and to carry over FY 1985 funds to reduce the amount requested for FY 1986. Hence, the decline results in HHS R&D as shown above.

- Set in the context of these kinds of declines in the non-defense area, NSF's 6.9 percent increase looks rather good.

- However, on the negative side, total basic research is virtually flat — up 1.1 percent from $7.8 billion in FY 1985 to $7.9 billion in FY 1986. This is a significant decline in constant dollars, assuming a 4 percent inflation rate. One of the major factors in this trend is the HHS/NIH story, as noted above. HHS supports about 39 percent of total Federal basic research, while the NSF supports about 17 percent and the Defense Department, about 12 percent.

Summary Point: The Amount of U.S. Investment in R&D Has Been and Remains Large -- Although There Are Problems as Suggested by Certain Key Comparisons, Domestic and International

Defense/Non-Defense Comparisons: FY 1981-1986

To obtain a somewhat longer perspective than is given by a comparison of FY 1986 and 1985, I will briefly show several key comparisons for FY 1986 and FY 1981, the beginning of the Reagan Administration.

- From FY 1981 to FY 1986, total non-defense R&D is down 8 percent in current dollars and is down 21 percent in constant 1972 dollars -- a substantial real decline.

- For the same period, total defense R&D is up 129 percent in current dollars and is up 67 percent in constant dollars — showing strong real growth.

- Total basic research is up 47 percent in current dollars and is up 23 percent in constant dollars, with defense accounting for about one-fourth of the increases.

- Except for the NSF and NIH, all non-defense agencies of government have experienced real reductions in their R&D budgets during the FY 1981-1986 period, some of them quite serious, e.g., the Alcohol, Drug Abuse and Mental Health Administration (ADAMHA).

These trends reflect clearly stated Administration policies and priorities during the past few years. While R&D in the aggregate — including basic research -- has been treated very well indeed, it is necessary to raise several cautionary points.

First, if defense and space R&D continue to increase their shares of the total Federal R&D budget, it will be very difficult to support other non-defense R&D even at current levels.

Next, as one looks ahead to the growing family of very large-scale technological commitments, such as the space station and space-based anti-satellite defense systems, the squeeze on available R&D resources could become severe. The combined costs of even a few of these very large projects could add up to many tens of billions of dollars.

Finally, it is surely not unreasonable to be apprehensive about substantial displacement impacts upon resources for general science. Further, there could be severe displacement effects on the supply of scientists and engineers, on university-based research, and upon the applied research that leads to innovation and economic competitive strength.

KEY INTERNATIONAL COMPARISONS

It is clear that very large numbers are seen when we examine total R&D spending in the United States. Further, as close study of the most recent (1982) issue of the National Science Board's Science Indicators shows, the United States still maintains overall scientific and technological leadership in its absolute investments in R&D, contributions to scientific and technical literature, positive balance in R&D-intensive trade, and the sale of technical knowledge.

However, we cannot examine the large U.S. numbers in isolation. As was noted in the Science and Technology report of the Commission on an Agenda for the Eighties, "the sheer size of the U.S. economy results in larger R&D expenditures than those of other countries," but "taking these data in comparative perspective raises serious concerns about international economic competition."

Let me cite several of these comparative perspectives.

- The data in Appendix 1 of my statement shows that from the mid-1960s until about the mid-1970s U.S. R&D was on a plateau; only in 1976 did a distinct growth period begin. And while the U.S. was on this plateau, other nations were experiencing substantial real growth. One indicator of the strong, relative growth of others is this fact: In the 1970-period, total U.S. R&D was twice that of France, West Germany, the United Kingdom and Japan combined; by the 1980-period, the combined R&D totals of the same countries equalled that of the U.S.

- This observation relates directly to the data in Appendix 2 which shows that, as a percentage of GNP, total R&D spending in the U.S. declined steadily from 1964 until a modest turnaround began in 1979. The comparable numbers from Japan, West Germany and the U.S.S.R. increased steadily and substantially during the no-growth/relative decline of the U.S.

- Perhaps of more direct relevance to the competitive international economic scene is the information in Appendix 3 which shows the ratios of civilian R&D expenditures to GNP for selected countries. The substantially larger ratios for Japan and West Germany are significant and substantial in terms of their international economic performance.

- Closely related, and worth noting in terms of international business and economic competition, are the following data: In recent years, Japan has allocated only about 2.4 percent of government R&D to defense, West Germany about 9.4 percent and France about 33 percent -- compared to about 65 percent for the U.S.

- Another facet of the FY 1985-1986 no growth in Federal basic research (shown in the previous section) is demonstrated on page 199 of Science Indicators: 1982. There is a distinct and substantial underinvestment by the U.S. in the advancement of knowledge (basic research) compared to some of our international economic competitors -- our major European allies and Japan. Further, as shown on pages 47-48 of Science Indicators and pages 12-14 of National Patterns of Science and Technology Resources: 1984, there were real declines in the amount of U.S. basic research from the late 1960s until the mid-1970s. At that time both the Federal Government and industry began to make constant dollar increases. While the industry component has continued to experience sustained real growth in the range of 7 percent per year, the Federal Government's support has been much less steady -- ranging from a decline of 1 percent in 1982 to a 7 percent increase in 1984.

Clearly we are a nation which still maintains a scientific and technical leadership role in the world, although just as clearly others are catching up. As a cautionary note to this leadership appraisal, I would summarize several Science Indicators observations. U.S. inventive activity appears to have decreased relative to some foreign competitors. More directly troubling is that the U.S. share of world exports in R&D-intensive products continue to decline. And, as previously noted, other nations continue to increase their R&D investments and activities relative to the U.S. -- particularly in civilian R&D. This is not a set of circumstances and trends which warrants complacency.

SCIENCE, TECHNOLOGY AND THE ECONOMY

Maintaining Our Scientific and Engineering Strength with Appropriate Balances Between Defense and Non-Defense R&D is Central to Powering Our Economy and Providing for Our National Security.

Economists and other scholars have given much attention to understanding the factors that contribute to economic growth — although the number of such researchers focusing specifically on scientific and technological considerations is not large. Even so, such individuals as Edward Denison, Edwin Mansfield, Theodore Schultz and William Nordhaus have reported results which suggest that scientific and technological advances, or the growth of knowledge, have been a major source of economic growth over both short and long periods since 1929.

These findings have powerful implications for policy — both in the public and private sectors. In going to the heart of the matter, investment in building the stock of knowledge -- in science, technology and education — appears to be at least as effective as investment in capital stock (production equipment, tooling and physical plant) in powering economic growth. Such ideas have important implications for the entire range of budget and tax issues now before the Congress, some of which appear as part of the on-going industrial policy debate.

As I have already noted, the significant R&D budget increases in the Federal sector of the past few years have been primarily in military R&D.

And these very large increases are for the most part being allocated to weapons development. This is an important point because it is very much an open question as to how much "transfer" to the private sector and long-term economic growth results from military R&D, especially weapons development.

This defense/non-defense division inevitably becomes part of the policy debate on the respective roles of the Federal Government and the private sector as the international competitiveness topic has assumed greater and greater importance in recent years. And taken together with the earlier cited international comparisons — particularly the greater focus on civilian R&D by our strongest economic competitors -- we must be quite careful about assuming that "all is well" because aggregate Federal R&D amounts are increasing at impressive rates.

An essential aspect of "appropriate balance" must deal with the possible long-term implications of real no-growth or declines in civilian Federal R&D. Moreover, the possible reallocation of large numbers of scientists and engineers to military purposes could have serious negative consequences for the private non-defense sector.

Another central feature of "appropriate balance" deals with time horizons. There are enormous pressures at work in this country — in both the public and private sectors -- for short-term payoff. Often such pressures are antithetical to the time requirements of an effective research and development program. Indeed, I would go as far as to say that a worrisome flaw in our basic thinking, our reward systems, our policy making structures, and in the ways we work and live are bound up with "the short-term syndrome."

It has been widely argued in the general media as well as in academic settings that differences in perspective on "the short-term syndrome" divide much of Japanese industrial thinking from that of U.S. counterparts. For example, it has been reported that U.S. corporate research in some industries has lagged behind that of Japan mainly because of U.S. preoccupation with short-term payoffs. It was argued that financial pressures worked against the long-term orientation needed for successful scientific work.

Pressing this point, Leighton Smith, an Arthur Anderson & Co. partner with long experience in Japan, has argued that labor relations are important but that the key to Japanese success is their orientation to a long-term point of view. Smith claims that until U.S. boards of directors decrease their emphasis on the current quarter's results and free up management from "fire-fighting" to concentrate on markets down the road, American industry's markets will continue to be eroded by the Japanese.

The same concerns can be expressed about Federal research and development. For example, within the recent past there has been heavy pressure placed upon the Environmental Protection Agency to focus much of its R&D upon short-term problems. This is understandable in a mission-oriented agency, but it can be overdone. Such trends demand careful scrutiny by senior officials in government and in the private sector; unchecked, they may will sow the seeds of future failure on a broad scale.

Industrial Innovation

In recent years, concern about the trends described above -- domestically and internationally — has taken the form of what is called "the industrial policy debate." A specific focus of this debate has been on the rate of U.S. industrial innovation, which is seen by some as declining. Further, some have seen negative consequences of the perceived innovation decline in terms of U.S. economic growth, productivity improvement and international trade competitiveness.

This debate is very complex and is often polemical rather than analytical. We need a lot of objective inquiry from different perspectives to sort out these deeply interrelated questions and provide a stronger basis for wise policy. It may well be that we need additional ways to increase and encourage R&D investment; hence, the direct connection to today's hearing. But Federal budget increases are only one part of a much larger set of possible actions. Still, there is strong Federal interest in these issues.

In fairly rapid order, the following areas have been addressed in legislation by the President and the Congress:

- o A major R&D-related initiative of the 97th Congress was the Economic Recovery Tax Act of 1981 (P.L. 97-34). Provisions of this law are intended to stimulate private R&D investment and charitable donations of equipment to universities.

- In the 98th Congress, P.L. 98-462, the National Cooperative Research Act of 1984, called for the rule of reason to be applied in anti-trust law with respect to joint R&D ventures.

- In a landmark effort, P.L. 98-620 provided amendments to Patent and Trademark Laws which give exclusive licenses to private contractors for patents arising from R&D work they do for the Federal Government.

- In the area of university-industry-Government cooperation, Congress has done two things of note: (1) enacted the Stevenson-Wydler Technology Innovation Act which authorized the establishment of generic technology centers to encourage universities and industry to work together and, (2) The NSF has been encouraged to support on a modest scale university-industry cooperation.

Taken together, this is an impressive set of actions on a broad front. And while I am familiar with the jurisdiction problem in Congress, I hope your subcommittee will continue in the future to follow this area closely, providing whatever coordination and overview it deems appropriate. Much is at stake and the effort to understand these problems more deeply is certainly in the national interest.

INTERNATIONAL SCIENCE AND TECHNOLOGY

One of the main features of the domain of science and technology in the decades following World War II has been the major presence of the United States on the international scene in a variety of ways -- in international governmental bodies, in international scientific groups, and as individuals. A principal tenet of our foreign policy has been the encouragement of full U.S. participation in the international scientific and engineering communities -- communities which transcend political boundaries and social and cultural traditions. Sharing the results of scientific research and engaging in a wide assortment of international exchanges between and among developed and less developed nations alike have become central characteristics of these communities.

The growing interrelatedness of the world, a rising consciousness of the imperative to view many problems globally, and plain self-interest in keeping open our windows on science in the rest of the world would seem to call for even greater emphasis and higher priority on activities and programs in support of international science and technology. However, I regret to say that there has been some slippage in recent years. Those who care about American leadership in world science, as well as American contributions to the general well-being, should take an interest in this problem.

In the largest of our international scientific and technical programs — that of the Agency for International Development — there seems to be ambivalence: on the positive side, considerable interest in the scientific quality of specific projects; but apparently little interest in a broad, coordinated approach to scientific cooperation that would involve working closely with other government agencies and the scientific community. In 1978 Congress made a valiant effort to bring about a more effective coordination process for Federal international scientific and technical activities -- the so-called Title V role of the State Department which included an annual report. However, the annual reports have been a very low priority effort at State -- under Democratic and Republican Administrations alike -- and few independent observers would declare the process or the reports effective.

I find the lack of strong focus and the paring down of our international participation especially regrettable as I look at the very special opportunities and problems emerging in the developing world. These nations are increasingly coming to recognize that science and technology offer great hope in meeting their developmental aspirations for economic and social progress. And they have great respect for American strength in science and technology. It would be an immensely grave mistake to forego these opportunities for American leadership and contributions to the general well-being. U.S. participation in selected bilateral arrangements with countries meeting a set of prescribed political criteria is a necessary but far from sufficient response to this great challenge.

Aside from humanitarian desires for generally making this world a better place for all, there are additional reasons for arguing that it is in the best interest of the United States that we help in the application of science and technology for Third World development. Trade data shows that we export more goods and services to Third World countries than to Western Europe and Japan combined. We have trade surpluses with these countries -- a rarity elsewhere in the world.

For the long-term, and in addition to the more traditional aid programs, we should be placing strong emphasis on assisting Third World countries with science-transfer and the development of effective educational structures and systems. We should be establishing a wide variety of cooperative research efforts and exchanges focused on Third World interests and problems. And where Third World countries and their scientists and engineers have the interest and capabilities we should encourage their active participation in the larger global issues that transcend national boundaries.

UNESCO

I would like to make a few remarks on UNESCO. Let me begin by observing that the National Academy of Sciences concluded that among all UNESCO programs ($47 million), the science programs ($14 million) rank high in terms of effectiveness and usefulness to the United States. It is my understanding that the Department of State has identified $2.7 million of its own funds to be used to cover significant U.S. international scientific activities that would go unfunded due to the U.S. withdrawal from UNESCO. Otherwise, we have been unable to discern what, if any, coverage there will be for the programs formerly carried out by UNESCO.

There is definitely nothing in the NSF budget request for this purpose. It would appear that, previous assurances notwithstanding, the UNESCO withdrawal will lead to valuable work not being done. If the Congress is so inclined, the NSF could be given responsibility for managing the funds for the selected activities. It has a distinguished track record in managing and supporting international scientific activities.

East-West Relations in Science and Technology

As special topics under international science and technology, I would now like to address two subjects: (1) Support for the International Institute for Applied Systems Analysis (IIASA) and (2) U.S.-U.S.S.R. bilateral relationships in science and technology.

IIASA

We at the AAAS believe that IIASA effectively promotes cooperative research among established scientists — and young scientists as well -- from East and West and some Third World countries on a number of global problems. We further believe that this is done in a context that advances overall U.S. national interests. For such reasons, AAAS has recently joined in a consortium of U.S. non-governmental scientific associations to support the work of IIASA.

The current Administration's position on IIASA is that core or institutional support not be provided from the U.S. Government, but that IIASA is free to solicit and compete for grants and contracts from U.S.

science agencies, subject to State Department approval. This is a step in the right direction from an earlier and more restrictive position but it does not go far enough; a small nucleus of assured funding is highly important to provide a basis for an effective long-term program.

Therefore, I would place a recommendation before the subcommittee: that you consider recognizing the importance of IIASA both to the advancement of international science and to U.S. national interests and that you authorize institutional support at a level of approximately $1 million per year, about one-third of the former level. We judge this would be enough to assure a viable program when supplemented with project support by governments and support from the private sector.

U.S.-U.S.S.R. Relations

Relations of all kinds between our two countries have been on the decline since the late 1970s, beginning with the invasion of Afghanistan. In 1982, three of the eleven bilateral agreements between the U.S. and the U.S.S.R. in the areas of science and technology, space, and energy were allowed to expire -- with neither party seeking renewal. Since then, relations have remained chilly and, following the KAL incident in 1983, the President also suspended the transportation agreement.

However, in June 1984 the President gave an important address in which he endorsed scientific and scholarly exchanges. He announced that he was authorizing renewed cooperation under the existing agreements, and that the agencies responsible for these programs should develop more active programs. He did not suggest the re-establishment of those agreements which had been allowed to expire. Since then, the progress has been modest but real.

Given the above cited progress, the findings of a June 1983 report from the State Department to the Congress which found positive benefits to the U.S. from the U.S.-U.S.S.R. bilateral S&T program, and the recent initiative between the National Academy of Sciences and the Soviet Academy, I would ask this subcommittee to explore with the Administration the reinstatement of the bilateral S&T agreement as part of a constructive and forward-looking move in improving U.S.-U.S.S.R. relations.

SCIENTIFIC COMMUNICATION AND NATIONAL SECURITY ISSUES

I would like to take a few moments to commend the role that the NSF has played in trying to clarify the responsibilities of U.S. scientists under the Export Administration Regulations (EAR). Ambiguous language in the EAR on the export control of technical information has caused much concern and confusion within the scientific and engineering research communities over the past several years.

This confusion centers on the extent to which traditional communication is subject to regulation. I understand that the Office of the General Counsel at NSF has been instrumental in developing a proposal to revise the EAR in such a way as to relieve researchers of the burden of determining whether dissemination of knowledge to foreign colleagues and students could result in prosecution under the Export Administration Act.

The NSF proposal was reviewed and approved by an OSTP Advisory Committee on Scientific Communication late last year. The main idea of the proposal is to establish a General License authorizing the unrestricted dissemination of scientific and technical information not otherwise subject to contractually agreed upon national security or proprietary limitations. A General License would also apply to dissemination of information that is consistent with any such contractually-imposed controls, once all restrictions have expired or have been removed.

Limiting application of export controls to cases where a researcher violates contractual obligations is consistent with the recommendations of a panel convened by NSF in January 1984 and those of the Corson Panel convened by the National Academy of Sciences in 1982. Both panels concluded that the Government should rely primarily on contractual rather than regulatory restrictions in the rare instances where some information dissemination restrictions on scientific research are appropriate.

In concluding this section, I again would like to commend the NSF for taking the lead in airing these vitally important issues and in developing a workable solution to the problems encountered by the research communities in interpreting the EAR. Achieving a proper balance between legitimate national security interests and those related to freedom of scientific communication requires a fine sense of judgment. I hope the proposal, as approved by the OSTP Advisory Committee, is adopted by the Department of Commerce quickly so that the chilling effect of current EAR language on scientific communication can be vanquished.

SCIENCE POLICY STUDY

I do not intend to raise substantive issues on this topic and only wish to commend the Committee and its members for undertaking this important study. This long-range overview role by a Committee of the Congress is too seldom invoked; your work could well serve as a model for others in undertaking the kinds of comprehensive inquiries which lead to good policy formulation. I am sure you will have many things to read during the course of your study, but I particularly commend to your attention an article by Donald Kennedy, president of Stanford University. It is in a recent issue of Science. With your permission, Mr. Chairman, I would like to submit the article for the hearing record.

On another science policy issue -- a proposed Department of Science and Technology -- I would only say that we have some reservations about such an organization. At the appropriate time we hope we might have the opportunity to testify in some detail on this proposal.

COMMENTARY ON THE NSF BUDGET REQUEST

I do not intend to discuss specific budget numbers or line items in any detail. In the relatively short time since the budget was submitted to the Congress we have only been able to conduct quite general reviews and have certainly not looked at every budget element. However, I am prepared to make a number of comments about the budget and will also provide several recommendations for you to consider.

As I noted briefly in the overview of R&D section, it seems clear that the NSF budget -- at the aggregate level -- fared well in a climate of strong pressures to reduce spending and to come to terms with large deficits. The Administration is to be commended for adhering to its course in recent years of strongly supporting increases in the research programs of the Foundation. The budget increase this year of nearly 7 percent — primarily for research — is encouraging in an otherwise no growth picture for basic research, as was pointed out in the overview.

Those of us in the scientific community have been heartened by the vigorous way in which new Foundation Director Bloch has moved into his job and by the open way he has made himself available to advice from a wide variety of sources. He is a person of exceptional distinction. And while it may be possible to take exception to some of the organizational, program and budget decisions, it appears to be a management environment in which reasonable people may differ but still come to an understanding on reasonable terms.

Science and Engineering Education

You asked specifically for my views on science and engineering education. This is the organizational and program area where we find ourselves greatly puzzled and, as are many in the scientific and engineering communities, increasingly restive about the limited progress being made by the Foundation in "getting its act together." Again, since there are new members on the subcommittee, we would like to review a number of key points and highlights covering the past five years.

Background

Starting in 1980 with the publication of Science and Engineering Education for the 1980s and Beyond (prepared by the NSF and the Education Department), there has been a large number of studies, reports and books, all of which, in one way or another, point out the urgent need for the nation to strengthen its science and mathematics education. All of them have stressed that it is a time for action, and that this action must come from every level: local, regional, state and national. They have also stressed that there is so much to be done, that there are important roles to be played in both the public and private sectors.

While there are differences on just what the Federal role ought to be, there seems to be no disagreement that there is a substantial Federal role. Furthermore, there appears to be widespread agreement that the NSF and the Department of Education both need to provide some resources, as well as constructive leadership.

The Congress has decided, along with the Administration, that the major role of the Department of Education in relation to science and mathematics education is to take the form of block grants to the states, and the NSF is to remain as the chief Federal instrument for influencing and providing leadership nationally in science, mathematics and engineering education.

Among the national studies, one of the most important was commissioned by the National Science Board itself. Called the Commission on Precollege Education in Mathematics, Science and Technology, its findings were made available in "A Report to the American People and the National Science Board," entitled Educating America for the 21st Century: A Plan of Action for Improving Mathematics, Science, and Technology Education for all American Elementary and Secondary Students. The objective was to insure that the achievement of the American students would be the best in the world by 1995. The National Science Board endorsed the report.

Where Do Things Stand?

That clarion call for action has not, however, been followed up with any notable vigor by the NSF itself. This, despite firm notice from Congress since 1983 that, like it or not, the NSF was going to have the science education function. It seems reasonable to suppose that the NSB Commission report would be the first step in a thoughtful and energetic response to national needs as set forth in the report itself and which were strongly emphasized by Congress.

First, for the past several years NSF has not spent the money made available to it by Congress for precollege science and mathematics education.

- In FY 1983 $15 million was available but only $1.1 million was spent.

- In FY 1984 $68.6 million was available (from new appropriations and carryover) but only $37.2 million was spent.

- In FY 1985 $87.0 million is available (from new appropriations and carryover) but $31.4 will be carried over to FY 1986.

No one is suggesting that NSF spend money recklessly, but surely over such a span of years it would be possible to expend these relatively small amounts thoughtfully and usefully, when the public demand and the fundamental requirements are so great. Of course, the NSF and the nation itself suffered a serious blow when the Education Directorate was essentially destroyed in the first year of this administration. Surely the time is at hand for recovery. This is an urgent national need. No other entity, public or private, can replace the NSF in science education.

There is real urgency for NSF to set in motion the planning steps on how to organize itself and conduct effective programs according to a coherent strategy in keeping with the Board mandate. Congress itself was troubled by this state of affairs and, apparently losing patience, last year decided to require the NSF to get itself on track in education. It appropriated $2 million to enable NSF to seek outside help in setting specific goals, short- and long-term, in aligning priorities, and in budgetary and organizational planning.

As of now, no contract has been set in place and it is unknown when such a plan will finally emerge. This is a matter you may wish to inquire into. It is possible that your subcommittee may wish to place this topic on your oversight agenda. We deeply believe that continuing Congressional interest will be essential to achieve the national goal in the critical field of science education. Your efforts can only be a positive help to Mr. Bloch as he sorts out the pieces of this puzzle and provides the necessary leadership.

Other Actors in Science and Engineering Education

The wide range and depth of problems in science and engineering education identified in the previous section have drawn a great deal of attention and action on the part of many organizations -- public and private. I am heartened by the growing variety of the responses by states, by school districts all over the country, by corporations, by private foundations (such as my own), by science museums, and by professional associations such as the AAAS.

Each of these entities tends to focus on special elements of science and engineering education. For example, a number of corporations have chosen engineering schools as their focus; the states have been revising curriculum and teacher requirements and standards; and the AAAS has concentrated its energies and programs -- with substantial private foundation support -- on pre-college science and mathematics education.

Because they do not usually gain as much public attention as some of the other activities, I would like to point especially to the growing roles of science and technology museums in science education. All over the country, science museums are experimenting with new forms of reaching out to the people in their areas, and especially to the children. We at the AAAS have found the museums to be uniquely valuable partners in the realm of science education; thousands of our members are now participating in volunteer programs with science museums all over the country.

It is possible that some could conclude that because of this array of activities in science, engineering and mathematics education, there is a diminished role for the NSF. We strongly differ with such a point of view. Indeed, as I stressed earlier, the need for the intellectual leadership and coordinating role of the NSF is stronger than it ever was. No state or foundation or corporation can replicate the special kinds of talent that the NSF can marshall in order to develop the long-range strategies and programs necessary to cope with the urgent problems that face us on a national scale.

NSF International Science and and Engineering Programs

Although I have discussed general international science and technology matters at some length earlier, I would like to focus this part of my testimony directly on NSF international programs. Appendix 4 contains a summary of what NSF considers as its international activities.

A review of why NSF supports international activities in science and engineering reveals two reasons: the first relates to the enhancement of science and engineering in the United States and maintaining a position of leadership in critical areas of science and technology through close contacts with centers of excellence in other countries; the second relates to U.S. foreign policy interests and the role of science and technology in advancing those interests.

Often the nature of the research enterprise requires a strong international component for certain problems which are global in nature such as research on the weather, oceans, climate and various biological, geological and chemical cycles. In yet other cases, international collaboration is necessary to provide U.S. scientists with access to specific resources -- physical, biological or geological available only in other countries. Finally, in some fields of research world leadership is found in the form of people and facilities in other countries; the ability to collaborate and communicate with these leaders is essential to the strength of U.S. science and engineering.

In support of foreign policy goals, international science and engineering activities can contribute to strengthening our national defense, to improving the economies of developing nations as earlier discussed, to reducing East-West political tensions and improving general understanding, and to strengthening ties with our allies. Increasingly the Executive Branch has used bilateral science agreements as a form of cooperation with other nations.

For all these reasons, maintaining close and varied links between science and engineering in the U.S. and other countries is vitally important to both domestic and foreign policy goals. The question, then, is how international activities fare in the proposed NSF budget.

First, as Appendix 4 shows, the total seems to be rising modestly; however, it is important to note that the small parts of the budget related to cooperative science efforts under a large number of bilateral agreements administered by NSF actually have been reduced in FY 1986. This turns out to be a few hundred thousand dollars per country for a total of about $7 million. I find this priority rather difficult to reconcile with the overall importance of these cooperative agreements. The $7 million comes from subtracting the National Academy of Sciences amount (for administering special agreements with the Peoples Republic of China, for example) of a little over $4 million form the $11.4 million estimate for FY 1986.

Today, I am not prepared to address in detail other elements of the international program -- such as the composition of the disciplinary area research projects which NSF estimates at $81.5 million for FY 1986. In view of the intimate way the world is now bound together, and the growing concerns about American leadership, the subcommittee may well find it useful to inquire into this matter at a subsequent date.

In summary, I raise a cautionary word as to whether the budget reflects the kinds of priorities which should be accorded the international area -- or whether we see in another way some of the "pullback" across-the-board in international science and technology I referred to earlier.

Programs for Women, Minorities and the Handicapped

First, and very important, we wish to applaud Mr. Bloch for his concerted efforts to increase the amount of data available in the NSF needed to monitor its equity efforts. In terms of specific actions, we think it very positive that the following actions have been or are being taken:

- The establishment of one new program and one new activity last year that address needed areas: (1) Research Opportunities for Women, a program for new women investigators who have not been a recipient of previous federal research support as a project director; and (2) Research Facilitation Awards, an activity that would augment grants -- to provide additional support that might be required by a disabled scientist, engineer or student on a grant -- to adapt scientific equipment, or obtain specific assistance to accommodate to a disability.

- The support of programs in FY 1986 that have special impact on minorities, women and handicapped.

- The continued emphasis in every directorate to address equity concerns.

NOTE: For a more complete review of the special programs in this area, please see Appendix 5.

On a less-than-positive note, however, I need to point to the absence of programs at the college level in Science and Engineering Education. This absence greatly hampers efforts for minorities, women and handicapped persons because there are retention problems at this level which cannot be addressed under the present program structure. At the same time, we need to expand the use of the option to involve undergraduate students from these groups in research funded out of the regular research grants.

Further, there is significant underfunding of the Research Opportunities for Women Program. Even a doubling would not begin to address the level of proposal pressure being experienced. Four hundred and forty applications to the program in FY 1985 will lead to the granting of seven awards.

More generally, we hope to see improvements in the Directorates in their efforts to increase participation by minorities, women and physically handicapped persons. We would like to see the efforts to bring these groups into the scientific mainstream integrated into the on-going operations of the Foundation. Until that integration takes place on an adequate scale, we need strong targeted programs that build toward enduring institutionalization.

Finally, we hope that the reorganization of the National Science Board means growing attention to equity issues within the broad context of NSF's concern for talent. We would hope that the Board will recognize that the largest pool of talent available to do the work of science in the next century is the one whose potential to contribute has been ignored too long -- minorities, women and handicapped persons. The nation must fully utilize this great pool of talent in the future.

Program on Ethics and Values in Science and Technology

In the course of reviewing a large, multi-million dollar budget, it is all too easy to overlook small programs which have been set aside to make way for new initiatives or for projects which have been judged to be of higher priority. One such item is the NSF Program on Ethics and Values in Science and Technology -- or EVIST as it is called. I deeply regret its absence.

EVIST has provided support for research studies, workshops, conferences, symposia and publications on a variety of important topics. The goal of the program has been to provide an explicit focus on the ethics and values associated with the acquisition and use of scientific and technical knowledge. It has represented a symbolic commitment by the NSF to the principle that scholarly research has much to contribute to our understanding of contemporary controversies involving science and technology.

EVIST is the only program in the entire Federal Government which has provided sustained support for work on ethical and value issues arising from biomedical research as well as science and technology more generally. A brief review of recent EVIST awards illustrates the importance of the research topics it has supported:

- Ethical and value conflicts in food safety decision making
- Ethical implications of trade secrecy, patents and related property

controls for science and technology

- Risk-setting, risk-taking, and the introduction of new technologies
- Ethical issues in approaches to research on mental illness and women
- Ethical responsibilities and practice in the use of animals in biomedical and behavioral research
- Ethical issues in human gene therapy
- Moral decisions in discovering and controlling occupational health hazards

The AAAS and other professional groups and academic centers have set up science and ethics programs over the past decade, many of which have been stimulated by the EVIST program. For example, the AAAS has focused increasing attention on the ethics and values area through its Committee on Scientific Freedom and Responsibility; moreover, we have incorporated such ideas into the fundamental objectives of the Association. I find it rather ironic that this very success of the EVIST program is one of the major reasons being stated by NSF for its discontinuance; it is as if the undisputed success of the NSF in helping to establish scientific centers of excellence in chemistry or mathematics were used to justify withdrawal of NSF support.

In effect, the NSF position is that supporting the EVIST-type research should now be a private sector responsibility. In part they are correct, foundations, universities, corporations, and associations such as our own should be supporting work in these areas. But is not correct to conclude that these issues are totally a private sector responsibility. We believe that the NSF can and should continue to provide an intellectual leadership role and act as a catalyst for other organizations -- a role it has performed well and often.

We believe that the Federal Government -- and the NSF -- cannot afford to look the other way when crisis and conflict arise from ethical and value issues in science and technology. In the absence of sustained and vigorous scientific inquiry, we are more likely to be left with rhetoric, polemic and anecdote as the basis for solving such problems.

I hope the subcommittee will agree. Specifically, we hope that in your review of this budget you will consider continuation of the EVIST program in its modest form.

Social, Economic and Behavioral Sciences

These program areas have been near the center of discussion of NSF budget reviews in recent years. It is encouraging that the social and economic sciences area has received a healthy increase for FY 1986 of $5.4 million to a total of $33.9 million; this is a rather better showing than was achieved by the behavioral sciences where the increase of about three percent probably means some loss in constant dollars.

We hope the subcommittee will continue its support for these science areas; your actions have been vitally important in recent years in keeping research in these fields alive.

SUMMARY

Mr. Chairman, again let me thank you and the other members of the Committee for this opportunity to be with you today. In my appearances before congressional committees over the years I have developed a high respect for those of you in the Congress. It is reassuring to observe at first hand the deep understanding held by Members of Congress on the vital set of relationships between science, technology and the well-being of our nation and the rest of the world.

Finally, I would like to make several concluding observations and recommendations in summarizing my views:

(1) In looking at the overall R&D picture, the U.S. remains strong and the general state of science and technology is reasonably healthy. My major qualifier is that we probably have been tilting too far toward military R&D in relation to non-defense R&D. Close watch on this balance and its long-term implications is warranted.

(2) Examination of key international indicators suggest that other nations are gaining rapidly on the U.S. in vital areas of science and technology -- and particularly in areas related to performance on the highly competitive international economic scene. This is an important policy domain where Congress has been particularly active in recent years; your continued oversight in this area is strongly urged.

(3) Greater national focus -- public and private -- must be placed on longer-range perspectives vis-a-vis short-term outlooks.

(4) The importance of international science and technology calls for your close attention in the form of budget and policy reviews -- particularly for cooperative scientific and engineering programs, including those between the U.S. and the U.S.S.R.

(5) Another special feature of international science and technology which we commend to your attention is the delicate and intricate balancing of interests between national security and freedom of scientific and engineering research objectives.

(6) Overall, the budget for the National Science Foundation is a good, strong product. In a time of fiscal pressures, it represents a sound investment in the nation's future. Only in science and engineering education do we seem to have views that differ sharply from those of the Foundation; in the other areas, as noted below, we suggest several modest changes for your consideration.

- o NSF does need to give science and engineering education a higher priority, get itself organized and formulate a strategic set of programs which will meet urgent national needs.
- o In the context of the overall importance of international science and technology, the downward direction of cooperative science budgets at NSF does not seem to be the way to go.
- o While much progress has been made, the NSF needs to maintain a strong focus on integrating the concerns of women, minority and handicapped persons into the mainstream of research directorate activities.

- The EVIST program should not be terminated; it is far too valuable in its catalytic role, especially considering the modest level of funding at about $1 million per year.

This concludes my statement. Thank you.

APPENDIX 1

Trends in Federal and non-Federal R&D outlays: 1953 and 1960-84
[Percents]

YEAR	TOTAL	FEDERAL Defense related	FEDERAL Space related	FEDERAL Civilian related	NON-FEDERAL	Total National (Constant Dollars)	Total National (Current Dollars)
1953	54	48	1	5	46	$8,677	$5,124
1960	65	52	3	9	35	19,635	13,523
1961	65	50	6	9	35	20,584	14,316
1962	64	48	7	9	36	21,750	15,394
1963	66	41	14	11	34	23,733	17,059
1964	66	37	19	9	34	25,857	18,854
1965	65	33	21	11	35	26,896	20,044
1966	64	33	19	12	36	28,442	21,846
1967	62	35	14	13	38	29,241	23,146
1968	61	35	13	13	39	29,833	24,605
1969	58	34	11	13	42	29,586	25,631
1970	57	33	10	14	43	28,613	26,134
1971	56	32	9	15	44	27,814	26,676
1972	56	32	9	15	44	28,477	28,477
1973	53	30	8	15	47	29,147	30,718
1974	51	27	8	16	49	28,763	32,864
1975	51	26	8	17	49	28,153	35,213
1976	51	26	8	17	49	29,510	39,018
1977	50	25	8	17	50	30,506	42,783
1978	50	24	7	19	50	32,002	48,129
1979	49	23	7	19	51	33,612	54,933
1980	47	22	7	18	53	35,133	62,618
1981	46	23	7	16	54	36,859	71,912
1982	46	25	7	14	54	38,742	80,317
1983 (est)	46	27	6	13	54	40,784	88,153
1984 (est)	46	29	6	11	54	$43,329	$97,895

NOTE: Detail may not add to 100 percent because of rounding.
SOURCE: National Science Foundation

APPENDIX 2

National Expenditures for Performance of R&D as Percent of Gross National Product (GNP) by Country: 1961-85

YEAR	FRANCE	WEST GERMANY	JAPAN	UNITED KINGDOM	UNITED STATES	U.S.S.R.
1961	1.38	NA	1.39	2.45	2.73	NA
1962	1.46	1.25	1.47	NA	2.72	2.64
1963	1.55	1.41	1.44	NA	2.86	2.80
1964	1.81	1.57	1.48	2.29	2.96	2.87
1965	2.01	1.73	1.52	NA	2.90	2.85
1966	2.06	1.81	1.46	2.31	2.89	2.88
1967	2.13	1.97	1.52	2.29	2.89	2.91
1968	2.08	1.97	1.60	2.25	2.82	NA
1969	1.94	1.82	1.64	2.27	2.72	3.03
1970	1.91	2.06	1.85	NA	2.63	3.28
1971	1.90	2.20	1.85	NA	2.48	3.46
1972	1.86	2.21	1.86	2.11	2.40	3.71
1973	1.76	2.09	1.90	NA	2.32	3.81
1974	1.79	2.13	1.97	NA	2.29	3.74
1975	1.80	2.23	1.96	2.19	2.27	3.78
1976	1.76	2.15	1.93	NA	2.23	3.54
1977	1.76	2.15	1.93	NA	2.23	3.54
1978	1.76	2.24	2.00	2.24	2.22	3.54
1979	1.81	2.40	2.09	NA	2.27	3.59
1980	1.85	2.42	2.22	NA	2.38	3.76
1981	2.01	2.49	2.38	2.47	2.43	3.75
1982	2.11	2.58	2.47	NA	2.58	3.68
1983 (est)	2.16	2.57	2.58	NA	2.62	NA
1984 (est)	2.19	NA	NA	NA	2.63	NA
1985 (est)	NA	NA	NA	NA	2.71	NA

SOURCE: National Science Foundation, Organization for Economic Co-operation and national country sources.

APPENDIX 3

Estimated Ratio of Civilian R&D Expenditures[1] to Gross National Product (GNP) for Selected Countries: 1967-82

YEAR	FRANCE	WEST GERMANY	JAPAN	UNITED KINGDOM	UNITED STATES
1967	NA	NA	1.51	NA	1.88
1968	NA	1.80	1.59	NA	1.83
1969	NA	1.87	1.63	NA	1.79
1970	NA	2.01	1.79	NA	1.75
1971	1.46	2.25	1.84	NA	1.68
1972	1.47	2.20	1.84	1.50	1.63
1973	1.39	2.07	1.89	NA	1.62
1974	1.43	2.12	1.96	NA	1.57
1975	1.46	2.24	1.95	1.41	1.68
1976	1.44	2.15	1.94	NA	1.72
1977	1.44	2.18	1.92	NA	1.67
1978	1.41	2.18	1.94	1.52	1.69
1979	1.43	2.46	2.05	NA	1.75
1980	1.42	2.53	2.15	NA	1.86
1981	NA	2.58	2.34	NA	1.87
1982	NA	NA	NA	NA	1.96

[1] National R&D expenditures, excluding government funds for defense.

NA=Not available.

SOURCES: National Science Foundation and Organization for Economic Cooperation and Development

APPENDIX 4

NSF

	$ Millions				
	1983 Actual	1984 Actual	1985 Request	1985 Current Plan	1986 Estimate
INTERNATIONAL COOPERATIVE SCIENTIFIC ACTIVITIES					
o International Cooperative Science	—	11.8	4.4	12.5	11.4
o International Scientific Organizations and Resources	—	1.0	1.1	1.1	0.7
Sub-Total	9.9	12.8	5.5	13.6	12.1
INTERNATIONAL RELATED RESEARCH PROJECTS					
o Disciplinary Activities	--	73.5	--	76.9	81.5
SPECIAL PROJECTS					
o Antarctic Programs	—	22.5	—	24.8	26.8
o Ocean Drilling	—	26.3	—	27.6	28.9
	--	147.9	--	156.5	161.4

Source: AAAS

APPENDIX 5

Programs for minorities, women and physically handicapped persons at the National Science Foundation

BACKGROUND

The NSF prides itself on the fact that programs it has supported were always integrated. This includes teacher institutes held in the 1960s on the campuses of "white" institutions in the Southern U.S. But NSF's first attempt to proactively address the underrepresentation of minorities in science came via targeted programs established in the early 1970s.

The National Science Foundation has had various targeted efforts to address the problems of access to science and engineering careers by women, minorities and/or physically disabled persons since the 1970s. These have varied in scope depending on the interpretation of civil rights laws within the agency at the time.

COSIP-D was the first such targeted program. Established in 1972, its aim was to build institutional capability in science and engineering at historically Black colleges and universities. The program was eventually expanded to include colleges and universities whose predominant student population consisted of groups underrepresented in science and engineering (e.g., American Indians, Alaskan Natives, Blacks, Mexican Americans, Puerto Ricans). When the Department of Education (ED) was established in 1980, this program (now known as the Minority Institutions Science Improvement Program or MISIP) along with pre-college teacher training programs for grades K-5, were transferred to ED.

PRESENT STATUS

In ED, MISIP has had a rather tumultuous history with little sympathy or support from top administrators who have limited ground in running merit-based college level science education programs. There have been numerous attempts by Congresspersons to intervene on the program's behalf but with no results. The program remains "at risk" with only one full time staff person trained in science or mathematics, supporting practices and standards aimed at maintaining the integrity of the program. MISIP needs to be returned to NSF where it could provide a base around which to build other college-oriented programs.

In the mid 1970s, the NSF funded experimental projects and programs aimed at identifying and addressing the barriers to women and minorities' full participation in science and engineering. In the late 1970s, a formal Women in Science program was established which supported three types of activities: a contract to test the viability of a Visiting Women Scientists program for the high school level; Career Days for Women in Science and Engineering initially aimed at the college level; and a reentry program to help retool women who already held degrees in science but who may have been out of the workforce because of family responsibilities. All three programs demonstrated their successfulness in various ways.

One might well ask why were these particular programs supported: these were not necessarily *the most important* or leveraging activities that NSF might have undertaken. But out of the many program options examined by the National Science Foundation, these three were among those that, according to legal interpretations, could be done without violation of existing anti-discrimination laws. These programs were effective, but disappeared in the virtual dismantling of Science and Engineering Education (SEE) in 1981.

Programs for physically handicapped persons were given to NSF in 1977 by the Congress. This was a new special population to the Foundation even though civil rights legislation related to disability was passed earlier in the decade. The program was funded until 1981. Among the projects supported by the NSF PHIS (Physically Handicapped In Science) were curriculum and materials development projects for teaching science to sensory impaired students, summer programs for disabled youth, and workshops for teachers on how to teach science and math to students with various disabilities.

Two other targeted programs were also present in the old Directorate for Science Education: Resource Centers for Science and Engineering (RCSE) and the Minority Graduate Fellowship Program, both congressionally mandated. Minority science organizations testified for and supported the concept of Resource Centers. The program was based on the idea that the problems of minority access to science and engineering were systemic and that the solution must also be systemic. RCSE stressed the notion that all elements must come together in an overall plan to change the perception, teaching, access, place of science and technology in the school, homes, communities and higher education institutions. Each of four centers was funded at $2.8 million for four years. These centers were based at Atlanta University to serve the Southeastern U.S. (1978); University of New Mexico and New Mexico State University to serve the Southwestern U.S. (1979); University of Puerto Rico Rio Piedras and Mayaguez to serve the island (1980); and City College of the City University of New York to serve the Northeastern U.S. (1981). It was originally intended that seven centers would be established, booster grants given to help maintain existing centers, and a network of all centers developed to facilitate sharing of ideas. These plans were dropped in 1981. Two centers are still in operation (Puerto Rico and City College), but these will run out of NSF funds in 1985. The centers were very successful in developing, testing and institutionalizing effective intervention programs for minority and disadvantaged students.

The Minority Fellows program was developed because of the small number of minority students who were successful in the extremely competitive regular fellowship competition at NSF. Talented minority students found it difficult to overcome years of cumulative educational disadvantages and demonstrate their potential for success by way of high scores and grade point averages. The Minority Fellows program was part of a negotiated compromise between the House and the Senate in 1978 which disagreed over whether individual or institutional support was the better route to increasing the flow of minority talent into science and engineering careers. The fellows program persists to this day in the NSF since the problem that stimulated its formation persists -- too few minority science and engineering Ph.D's and too little success by minority applicants in the regular fellows program. The program also persists because it was yoked to the regular fellows program. The Minority Fellowship program gave NSF something else -- very clear, explicit report language that made clear legislative intent to address underrepresentation by minorities in science and engineering through programs -- institutional and individual. Such a broad mandate could not have existed in the past.

A modest program also existed in NSF in the early 1970s to support research by investigators in minority institutions and this continues as the Research Improvement in Minority Institutions Program.

In 1980, Congress passed Title II of the NSF Authorization Act of 1981 -- Equal Opportunity in Science and Technology. The law authorized support for a variety of programs, established the NSF Committee on Equal Opportunities in Science and Technology (CEOST), required biennial statistical reporting by NSF on the status of women and minorities in science and engineering, and required several reports from the White House.

The establishment of CEOST by NSF Director, John Slaughter, put into place a mechanism for ongoing monitoring and advisement on equal opportunity issues. When NSF Director, Edward Knapp, explored the place of targeted programs vs. mainstreaming equity efforts, CEOST was in place to help raise key questions about accountability, and monitoring. The decision was made to keep existing targeted programs such as Minority Research Institutions, and Visiting Professorships for Women but at the same time to require the various directorates in the Foundation to outline in detail how they would increase the participation of minorities, women and disabled persons in all their activities — as peer reviewers, on advisory committees and panels, as project directors, etc.

NSF Director Erich Bloch has worked effectively with CEOST and has moved forward aggressively to tackle such issues as: obtaining race, gender, disability information on project directors, assessing the current status of minorities, women and disabled persons on advisory committees and panels within the Foundation, developing a management information system that will allow NSF to monitor itself on a number of different equity indicators.

Mr. **Walgren**. Thank you very much, Dr. Hamburg. We appreciate that survey and comments that went along with it.

Let's turn then to Dr. Rosenzweig.

[A biographical sketch of Dr. Rosenzweig follows:]

ROBERT M. ROSENZWEIG
President
Association of American Universities
Suite 730, One Dupont Circle, NW
Washington, DC 20036

Education

B.A., 1952, University of Michigan
M.A., 1953, Yale University
Ph.D., 1956, Yale University, Political Science

Professional Experience

- 1955-57, Instructor, Political Science, Amherst College
- 1957-58, Congressional Fellow, American Political Science Association
- 1958-62, U.S. Office of Education:
    - 1958-61, National Defense Graduate Fellows Program
    - 1961-62, Special Assistant to the Commissioner
- 1962-83, Stanford University:
    - 1962-67, Associate Dean, Graduate Division
    - 1967-68, 1972-73, Director, Center for Research in International Studies
    - 1967-71, Associate Provost
    - 1971-74, Vice Provost; Adviser to the President
    - 1963-82, Lecturer in Political Science
    - 1974-83, Vice President for Public Affairs
- 1983-present, President, Association of American Universities

Publications

The Federal Interest in Higher Education, with Homer D. Babbidge, Jr., 1962.

Research Universities and Their Patrons, with Barbara Turlington, University of California Press, 1982.

"Faculty and Standards of Ethical Conduct," in Sidney Hook, et al., *The Ethics of Teaching and Scientific Research*, 1977.

Articles for various publications including: *AGB Report*, *Change* Magazine, *Christian Science Monitor*, *Chronicle of Higher Education*, *Educational Record*, *The Graduate Journal*, *Journal of Higher Education*, *Midwest Journal of Political Science*, *Los Angeles Times*, *Stanford MD*, *Stanford Today*, *Washington Post*.

Additional Offices, Honors, and Memberships

President, Association of Independent California Colleges and Universities, 1980-82; Vice President, 1978-80
Cushing Orator, American Society of Neurological Surgeons, 1984
Current Member: American Association for the Advancement of Science
American Political Science Association
Council on Foreign Relations
Foundation for Biomedical Research, Board of Directors
Soviet-Eastern European Studies Advisory Committee, U.S. Department of State

Personal

Date of Birth: August 27, 1931
Place of Birth: Detroit, Michigan
Family: Wife, Adelle; daughter, Kathryn; son, David

STATEMENT OF DR. ROBERT M. ROSENZWEIG, PRESIDENT, ASSOCIATION OF AMERICAN UNIVERSITIES

Dr. ROSENZWEIG. Thank you, Mr. Chairman. I appreciate the invitation to return to this committee and comment again on National Science Foundation budget on behalf of the Association of American Universities and the group of other associations of higher education institutions listed in my testimony.

You have before you my prepared remarks on the fiscal year 1986 NSF budget. In general, you'll see they're approving in tone and in substance. We recognize that the process of establishing priorities within the Foundation's broad mission is far from an exact science and that it inevitably and properly includes elements of judgment about which reasonable people can differ. Therefore, we have not attempted to fine tune the budget by suggesting shifts from one category to another.

I have no doubt that you will hear such requests. You may even find compelling reasons to support some of them. I urge on you in this regard if not abstinence, then at least self-restraint. It's my sense that the management of the Foundation has made a serious effort to sort out competing demands, indeed competing real needs, but they've done a good job of it and that science and engineering research and education have been rewarded with more resources as a consequence.

I would like to use these brief remarks to emphasize a few issues of science policy that affect the NSF program and that will, in turn, be affected by what the Foundation does over a period of a few years. The first of those has to do with the adequacy of our efforts to assure that a sufficient number of our best college graduates are choosing to prepare for careers in research and teaching. The graduate fellowship program of the Foundation has been a key part of that effort for more than 30 years. It has been gratifying to see that program begin once again to grow in numbers and importance, and though it's flat—the proposal is flat for the coming year—we look forward to further improvements in the years ahead.

That role of the Foundation is certain to become even more important if the President's proposals to cut back on guaranteed student loans and to eliminate the National Graduate Fellows Program and the Graduate and Professional Opportunities program are accepted by the Congress.

In that latter context, that of the Graduate and Professional Opportunities Program, I want especially to note that we have not been successful, as David Hamburg indicated, in recruiting and retaining significant numbers of minority students into Ph.D. programs, not simply in the sciences but in other fields as well.

It is essential, in my view, that we not grow impatient with the complexities that underlie that fact. In addition to reasons of justice and social comity, I don't believe that we're so rich and strong as a nation that we can afford indefinitely to lose the talent that resides in those communities of Americans.

The second issue of science policy, Mr. Chairman, that I want to emphasize is sometimes referred to, or variously referred to, as the infrastructure problem, the facilities and instrumentation problem, or as I believe is more descriptive, the capital shortage. Whatever its name, it's important to understand its causes.

Dr. Hamburg referred to and entered into the record an article by a former colleague of his and mine, Donald Kennedy, president of Stanford University, in a recent issue of Science magazine. In that piece Dr. Kennedy described the problem and its causes in what seems to me a useful way. "Our kind of science," he said—and I am quoting now—"is crossing a significant watershed. It is hard to know exactly where to locate the divide, but the terrain contains an important transition from people to property and from operating to capital budgets, at which point we must start worrying more about one-time equipment costs and facilities renewal than we do about salaries. On the maps, the territory on the other side of the divide is labeled 'big science.' "

He goes on to point out that a number of disciplines have crossed over the divide in the last decade, including organic chemistry, parts of solid state physics and molecular biology. High-energy physics has long been there, and others will surely follow.

The point, of course, is that changes in the funding requirements of science, especially the most advanced science, have not been matched by our capacity to respond to them. The most important cause of that discrepancy has been the withdrawal of the Federal Government from the funding of scientific facilities.

Now, sensible people won't spend a lot of time bemoaning that fact. Much better to spend our time figuring out what to do about it. In the few minutes remaining to me I want to bring to your attention two major obstacles that stand in the way of our getting on with the job.

The first of those is the lack of reliable information about the extent of the problem. The second is growing uncertainty and controversy about precisely where in the process of making decisions about the funding of scientific facilities the role of the Congress should lie. Let me say a few words about each.

In a sense, the fact that we lack systematic information about the extent of the facilities deficit and its distribution by field and by region is no excuse for failing to take some action. There is overwhelmingly persuasive testimony from individual institutions about the existence of a serious problem, and it is certainly not unknown for very important decisions—indeed even more important decisions—to be made on the basis of considerably less persuasive evidence than exists here.

But in another sense, the absence of the kind of knowledge I have described has been disabling. In its absence, what has taken hold in some circles is a belief or a fear that the problem is so large that to tackle it is either an impossibly large drain on resources or a useless exercise with the meager resources that might realistically be mustered.

Fear and despair don't provide a very solid basis for solving problems. I think that if the problem is given boundaries, as for example the instrumentation problem was by the 1980 AAU study, we can begin to make some sense of it. There are, I am sorry to say, some people in government who would rather not know the answers because they fear that the answers will produce demands for action. I respect the pressures under which they operate, but with respect, I insist that such a position is irresponsible and damaging. I hope that those attitudes can be overcome.

The second problem on my list is a product of the extraordinary pressures placed on universities by the difficulty of finding money to build and renovate facilities. That pressure has led, as you know even better than I, to an increasing recourse to direct appropriations for specific buildings on individual campuses. Surely the most important way to limit the further growth of that practice is to relieve the source of the pressure; that is, to provide facilities funding in the agencies for which institutions may compete. Had there been such regularly available funding over the last decade and a half, I don't believe that we would now be seeing nearly so much direct congressional action.

I fear, however, that even if funding of a regular kind were now to be provided, it would be hard to bring a stop to the practice. After all, no feasible amount of money can satisfy the needs of everyone. The temptation to turn to an alternate route of proven success may turn out to be irresistible.

It strikes me, Mr. Chairman, that we all have a primary interest in having American science and technology become as strong as it can possibly be. We also, I believe, share an interest in fair and objective decisionmaking in which the outcome is not determined either by the relative influence in Congress of the applicant's representatives or by a halo of assumed quality that may attach to programs because of the university in which they reside.

I think, in short, that we need to reach some new understandings about what kind of behavior is appropriate at which stage of the process and for what kinds of projects. I suspect that those understandings will not come quickly or easily. I wonder, though, if we might start by agreeing that it is desirable that no facility whose purpose is to house scientific work should be approved without its first having been reviewed for scientific quality by qualified professionals chosen by the agency which is to fund the project. Many alternatives would meet that test, and I advance it simply as a starting point for discussion.

This committee is in a key position to lead on this issue. It has, first of all, an obligation to protect the processes of the National Science Foundation, processes that have helped to produce the high quality of American science; and second, as participants in the broad study of science that the full committee is undertaking, you will have an important role in shaping both the questions and the answers.

Addressing the capital deficit in science is central to its future strength, and helping to remove the obstacles to reducing that deficit is a contribution that this committee can make.

Thank you, Mr. Chairman. I will be pleased to answer your questions.

[The prepared statement of Dr. Rosenzweig follows:]

STATEMENT OF

DR. ROBERT M. ROSENZWEIG

PRESIDENT

ASSOCIATION OF AMERICAN UNIVERSITIES

BEFORE

THE SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY

OF

THE COMMITTEE ON SCIENCE AND TECHNOLOGY

U.S. HOUSE OF REPRESENTATIVES

ON BEHALF OF THE

ASSOCIATION OF AMERICAN UNIVERSITIES
NATIONAL ASSOCIATION OF STATE UNIVERSITIES AND LAND-GRANT COLLEGES
AMERICAN COUNCIL ON EDUCATION
COUNCIL ON GOVERNMENTAL RELATIONS
ASSOCIATION OF GRADUATE SCHOOLS
COUNCIL OF GRADUATE SCHOOLS

FEBRUARY 20, 1985

MR. CHAIRMAN AND MEMBERS OF THE COMMITTEE:

MY NAME IS ROBERT M. ROSENZWEIG, AND I AM PRESIDENT OF THE ASSOCIATION OF AMERICAN UNIVERSITIES. I APPRECIATE THE OPPORTUNITY TO APPEAR BEFORE YOU TODAY ON BEHALF OF SEVERAL HIGHER EDUCATION ASSOCIATIONS TO COMMENT ON THE PROPOSED BUDGET AND FY 1986 AUTHORIZATION FOR THE NATIONAL SCIENCE FOUNDATION. THE AAU IS COMPOSED OF FIFTY PUBLIC AND INDEPENDENT RESEARCH UNIVERSITIES. MOST OF THEM RANK AMONG THE TOP THIRD OF THE LEADING 100 RESEARCH UNIVERSITIES THAT COMPETE FOR FEDERAL RESEARCH SUPPORT. THEREFORE, THEY ARE DEEPLY CONCERNED WITH THE FOUNDATION'S RESEARCH AND GRADUATE PROGRAMS. MY COMMENTS THIS AFTERNOON ALSO ARE OFFERED ON BEHALF OF SEVERAL OTHER HIGHER EDUCATION ASSOCIATIONS.

FIRST PRINCIPLES

RECENTLY DR. GEORGE A. KEYWORTH, SCIENCE ADVISOR TO THE PRESIDENT, APPEARED BEFORE THE COMMITTEE ON SCIENCE AND TECHNOLOGY TO PRESENT THE ADMINISTRATION'S VIEWS ON THE THE FEDERAL R&D BUDGET FOR FY 1986. I WOULD LIKE TO BEGIN MY STATEMENT THIS AFTERNOON BY BRIEFLY RESTATING THE SUBSTANCE OF SEVERAL FAMILIAR THEMES TAKEN FROM DR. KEYWORTH'S REMARKS. THESE ARE ALL POINTS WE HAVE ADDRESSED IN EARLIER TESTIMONY BEFORE THIS COMMITTEE. WE CONTINUE TO BELIEVE THAT THE RESEARCH ENTERPRISE WILL BE WELL SERVED IF THESE GUIDING PRINCIPLES INFORM OUR RESPONSE TO PRESENT CIRCUMSTANCES AND GUIDE OUR LONGER-RANGE R&D PLANNING AND BUDGETING. AMONG THE POINTS DR. KEYWORTH EMPHASIZED WERE THESE:

1. OUR SCIENTIFIC LEADERSHIP IS EXTREMELY FRAGILE. IT REQUIRES CONTINUOUS AND CAREFUL ATTENTION. SHORT-TERM BUDGET CONSTRAINTS ON OUR RESEARCH ENTERPRISE ARE ACCEPTABLE, BUT ONLY IF WE RECOGNIZE THAT THE LONGER-TERM HEALTH OF OUR PEOPLE, OUR ECONOMY, AND OUR SECURITY WILL REQUIRE A CONTINUOUS COMMITMENT TO INVEST IN THE NECESSARY EFFORT TO SUSTAIN OUR LEADERSHIP.

2. TECHNOLOGY AND TALENT ARE OUR TWO COMPETITIVE ADVANTAGES; NATIONAL INVESTMENT IN THEM MUST BE SUSTAINED.

3. EXPLOITATION OF TECHNOLOGY, MAINTENANCE OF ECONOMIC HEALTH, AND NATIONAL SECURITY REQUIRE PREEMINENCE IN BASIC SCIENCE AND A SUSTAINED COMMITMENT TO EXCELLENCE IN THE TRAINING OF YOUNG PEOPLE.

4. WHATEVER OUR FUTURE FISCAL SITUATION, HARD CHOICES LIE AHEAD TO FUND HIGH-PRIORITY RESEARCH FACILITIES. CONSTRUCTION, MODERNIZATION, AND RETOOLING OF OUR RESEARCH FACILITIES MUST RECEIVE PRIORITY ATTENTION IN OUR R&D PLANNING AND BUDGETING IN THE YEARS IMMEDIATELY AHEAD.

5. EACH OF THE MISSION AGENCIES OF THE FEDERAL GOVERNMENT OUGHT TO SUPPORT BASIC RESEARCH IN DISCIPLINES RELATED TO THEM. IMPLICIT IN THIS POINT IS A CALL TO MISSION AGENCIES TO BEGIN NOW TO REEXAMINE AND TO IMPROVE THEIR CAPACITIES TO DEVELOP AND MANAGE QUALITY BASIC SCIENCE AND ENGINEERING PROGRAMS IN FIELDS APPROPRIATE TO THEIR MISSIONS.

6. TALENT IS OUR MOST IMPORTANT NATIONAL RESOURCE. THE TRAINING OF OUR BEST YOUNG MINDS REQUIRES US TO PROTECT OUR RESEARCH AND TRAINING ENVIRONMENTS FROM THE DISCONTINUITIES OF START-AND-STOP FUNDING. WE RISK CHASING THE BEST YOUNG MINDS AWAY FROM SCIENCE AND ENGINEERING IF OUR RESPONSE TO IMMEDIATE BUDGETARY CONSTRAINTS IS ONE THAT CONSTRAINS CAREER CHOICES BY DISRUPTING OUR RESEARCH AND TRAINING ACTIVITIES.

7. A PREFERENCE FOR QUALITY--NOT QUANTITY--IS THE KEY. PRESENT CIRCUMSTANCES REQUIRE US TO MAKE THE MORE DIFFICULT CHOICES TO INVEST IN QUALITY RESEARCH AND QUALITY ADVANCED TRAINING RATHER THAN TO PURSUE A CONTINUOUS EXPANSION OF THE QUANTITY OF RESEARCH AND GRADUATE PROGRAMS. QUALITY IS THE KEY TO ATTRACTING TALENT, AND A COMMITMENT TO QUALITY IS ESSENTIAL TO MAINTAINING OUR TECHNOLOGICAL AND SCIENTIFIC POSITION.

8. MISALLOCATIONS OF OUR LIMITED RESOURCES WILL COMPROMISE OUR COMMITMENTS TO QUALITY AND EXCELLENCE IN OUR GRADUATE EDUCATION AND RESEARCH PROGRAMS, AND THEY WILL PLACE OUR SCIENTIFIC AND TECHNICAL LEADERSHIP AT RISK.

WITH THESE ORGANIZING PRINCIPLES IN MIND, WE OFFER THE FOLLOWING OBSERVATIONS ON THE FY 1986 BUDGET REQUEST OF THE NATIONAL SCIENCE FOUNDATION.

THE FY 1986 BUDGET REQUEST

FIRST, IN THIS MOST UNUSUAL BUDGET YEAR, THE NSF BUDGET AS PROPOSED FOR FY 1986 IS SOUND; IT MERITS SUPPORT. ALTHOUGH IT IS NEITHER AS BOLD NOR AS AMBITIOUS AS SOME PREVIOUS REQUESTS, THE NSF PROPOSAL IS GENERALLY A WELL-BALANCED AND SATISFACTORY ONE FOR UNIVERSITY RESEARCH AND GRADUATE PROGRAMS. IT DESERVES THE SUPPORT OF THE RESEARCH COMMUNITY AND THE ACTIVE SUPPORT OF THE CONGRESS. IT IS IN SATISFACTORY BALANCE AND DOES NOT CALL FOR SIGNIFICANT CORRECTION.

OF COURSE, IN VIEW OF THE PRINCIPLES SUMMARIZED ABOVE, IT IS PREDICTABLE THAT THE UNIVERSITY COMMUNITY AND MANY OTHERS WOULD PREFER TO SEE AN EVEN STRONGER COMMITMENT TO INVESTMENT IN BASIC SCIENCE AND ENGINEERING. PRESSING NEEDS, MOST NOTABLY THE NEED TO MODERNIZE UNIVERSITY RESEARCH FACILITIES IN WHICH FEDERAL RESEARCH PROGRAMS ARE CARRIED OUT, ONCE AGAIN REMAIN UNADDRESSED. BUT WE DO RECOGNIZE THE PRACTICAL FACTS OF THIS PECULIAR YEAR. FY 1986 DOES NOT SEEM TO BE ONE IN WHICH MAJOR NEW FACILITIES MODERNIZATION INITIATIVES WILL BE ENTERTAINED SERIOUSLY. INSTEAD, FY 1986 IS A YEAR IN WHICH THE CONGRESS OUGHT TO ENSURE THAT NSF AND THE OTHER MISSION AGENCIES BEGIN TO PLAN AND TO READY THEMSELVES TO HELP LEAD A NATIONAL EFFORT TO ADDRESS THIS TRULY NATIONAL PROBLEM. I WILL RETURN TO THIS LATER.

THE BUDGET RETAINS A REASONABLE AND APPROPRIATE BALANCE AMONG CORE RESEARCH PROGRAMS. AT THE SAME TIME, IT PURSUES NEEDED PRIORITY INITIATIVES, INCLUDING THE INTERDISCIPLINARY ENGINEERING CENTERS, THE PROGRAM TO IMPROVE ACCESS TO SUPERCOMPUTERS, THE CONTINUING EFFORT TO UPGRADE RESEARCH INSTRUMENTATION, AND RESEARCH RELATED TO BIOTECHNOLOGY. REASONABLE INCREASES TO MEET THE COSTS OF INFLATION AND PROVIDE FOR A SMALL MARGIN OF GROWTH ARE PROPOSED FOR MOST MAJOR RESEARCH PROGRAMS. WE ARE ESPECIALLY PLEASED TO SEE THE PROPOSED INCREASE FOR RESEARCH IN THE MATHEMATICAL SCIENCES. WE DO NOTE WITH CONCERN, HOWEVER, THAT THE SELECTED INCREASES ARE ACCOMPLISHED IN PART THROUGH THE TERMINATION OF SEVERAL, VALUABLE, SMALLER PROGRAMS, INCLUDING THE UNIQUE ETHICS AND VALUES IN SCIENCE AND TECHNOLOGY PROGRAM.

AS THE MAJOR INITIATIVES GO FORWARD, WE URGE NSF, THIS COMMITTEE, AND THE CONGRESS TO ENSURE THAT EACH CENTER RECEIVES ADEQUATE SUPPORT TO FUNCTION PROPERLY AND TO FULFILL ITS MISSION. THE BROADER RESEARCH COMMUNITY WILL NOT BE WELL SERVED BY A RAPID PROLIFERATION OF INADEQUATELY FUNDED SUPERCOMPUTER SERVICE CENTERS. NEW CENTERS SHOULD NOT BE PURCHASED AT THE COST OF IMPOSING INEFFICIENT OPERATION ON OTHERS. HERE, TOO, THE PRINCIPLE OF QUALITY RATHER THAN QUANTITY OUGHT TO BE THE GUIDE IN ESTABLISHING THESE IMPORTANT AND COSTLY ACTIVITIES.

CLOSELY RELATED TO THIS CONCERN IS THE NEED TO RETAIN A PROPER BALANCE IN FUNDING BETWEEN THE MAJOR NEW INITIATIVES AND FUNDING FOR COMPETITIVE AWARDS TO INDIVIDUAL RESEARCHERS. RECENT PROGRESS IN STRENGTHENING THE SIZE AND DURATION OF THE AVERAGE NSF GRANT SHOULD NOT BE ERODED BY A COST SQUEEZE IMPOSED BY THE NEW PROGRAMS. AGAIN, THE STRATEGY OUGHT TO FOLLOW THE PRINCIPLE OF MINIMIZING DISRUPTION OF ONGOING RESEARCH AND TRAINING ACTIVITIES.

THESE CONCERNS NOTWITHSTANDING, THE NEW ENGINEERING RESEARCH CENTERS, THE PROGRAM TO PROVIDE ACCESS TO ADVANCED SCIENTIFIC COMPUTING, THE PROPOSED CONTINUED INVESTMENT IN RESEARCH

INSTRUMENTATION, AND THE PROGRAMS TO STRENGTHEN OUR INVESTMENT IN PEOPLE--THE PRESIDENTIAL YOUNG INVESTIGATORS PROGRAM, POSTDOCS, AND THE GRADUATE FELLOWSHIP PROGRAMS--DESERVE THE SUPPORT OF THE CONGRESS. THE ACTIVITIES DESIGNED TO ENHANCE THE RESEARCH CAREER PROSPECTS FOR TALENTED WOMEN AND MINORITIES MUST CONTINUE TO RECEIVE PRIORITY ATTENTION. PRESENT BUDGETARY CONCERNS SHOULD NOT BE ALLOWED TO WEAKEN OUR COMMITMENT TO ATTRACTING THE VERY BEST YOUNG MINDS INTO RESEARCH AND TEACHING CAREERS, AND WE ARE PLEASED TO NOTE THAT THE BUDGET REQUEST ATTEMPTS TO PROTECT RECENT GAINS IN THIS AREA.

IT IS PROBABLE THAT SOME WILL TRY TO ARGUE THAT THE NSF BUDGET REQUEST IS SOMEHOW DEFICIENT. FROM ONE POINT OF VIEW OR ANOTHER, SUCH ARGUMENTS NO DOUBT WILL BE CORRECT. BUT WE RESPECTFULLY SUGGEST THAT NOW IS NOT THE TIME TO SECOND-GUESS THE UNDERLYING SCIENTIFIC AND TECHNICAL JUDGMENTS THAT ARE REFLECTED IN THE FOUNDATION'S BUDGET REQUEST. TO DO SO WILL IGNORE THE OBVIOUS AND CAREFUL BALANCING OF PRIORITIES REFLECTED IN THE DETAILED REQUEST. IF ATTEMPTS ARE MADE TO RESPOND TO SPECIAL PLEAS TO REALLOCATE SIGNIFICANT AMOUNTS OF FUNDS FROM CERTAIN RESEARCH PROGRAMS TO OTHERS, OR FROM RESEARCH ACTIVITIES TO OTHER FUNCTIONS, THE FUNDAMENTAL PRINCIPLES OUTLINED ABOVE QUICKLY WILL BE VIOLATED TO THE DETRIMENT OF THE ENTERPRISE OVERALL. THIS BUDGET IS A GOOD BUDGET. IT IS NEITHER SERIOUSLY OUT OF BALANCE NOR SO DEFICIENT AS TO JUSTIFY A REALLOCATION OF FUNDS AMONG THE MAJOR RESEARCH PROGRAMS OR FROM THEM TO OTHER PURPOSES. IF SUCH PROPOSALS ARE MADE, WE ASK THAT THE COMMITTEE REJECT THEM, AND, IF NECESSARY, ASK YOUR HOUSE COLLEAGUES ALSO TO REJECT THEM.

THE BUDGET REQUEST FOR THE DIVISION OF SOCIAL AND BEHAVIORAL SCIENCE MERITS A SPECIAL WORD. WE ARE PLEASED THAT THE BUDGET FOR THESE PROGRAMS REFLECTS A CONTINUING COMMITMENT TO RESTORE THEM TO A MORE APPROPRIATE POSITION AMID THE FOUNDATION'S PROGRAMS. THE INCREASES FOR THE DIVISIONS OF SOCIAL AND ECONOMIC SCIENCE AND BEHAVIORAL AND NEURAL SCIENCE REFLECT A RECOGNITION OF THE INTELLECTUAL VITALITY OF THESE FIELDS. FOR MOST OF THESE

DISCIPLINES, THE FOUNDATION IS THE MAJOR OR SOLE SOURCE OF FEDERAL INVESTMENT. DESPITE THE REQUESTED INCREASES, IT IS IMPORTANT TO NOTE, THESE PROGRAMS ARE NOT YET IN REAL TERMS BACK TO THEIR 1980 FUNDING LEVELS. WE THANK THE COMMITTEE FOR YOUR PREVIOUS SUPPORT OF THESE AREAS AND WE URGE CONTINUOUS SUPPORT FOR THEM.

SCIENCE AND ENGINEERING EDUCATION

THE FOUNDATION PROPOSES TO CONTINUE ITS SCIENCE AND ENGINEERING PROGRAMS AT CURRENT-YEAR LEVELS. WE SUPPORT THAT APPROACH FOR THE COMING YEAR. FOR THE PAST SEVERAL YEARS, WE HAVE JOINED WITH MANY OTHERS IN SUPPORTING THE DEVELOPMENT OF SOUND SCIENCE AND ENGINEERING EDUCATION PROGRAMS IN THE FOUNDATION. WE CONTINUE TO SUPPORT AN NSF LEADERSHIP ROLE IN DESIGNING ACTIVITIES TO STRENGTHEN PRECOLLEGE AND UNDERGRADUATE SCIENCE AND ENGINEERING PROGRAMS. NSF MUST RETURN TO A POSITION OF NATIONAL LEADERSHIP IN THIS AREA. WE SHARE A SENSE OF IMPATIENCE THAT MORE CANNOT BE DONE MORE QUICKLY, BUT WE ALSO RECOGNIZE THE MANAGEMENT DIFFICULTIES ASSOCIATED WITH AS AMBITIOUS AN UNDERTAKING AS THE PRESENT ONE. THEREFORE, WE BELIEVE IT WOULD BE A MISTAKE TO ACCELERATE FUNDING BEYOND THE LEVEL PROPOSED UNTIL THE PROGRAM IS FULLY PREPARED TO UTILIZE ADDITIONAL RESOURCES EFFECTIVELY.

RECENTLY DR. JAROSLAV PELIKAN, STERLING PROFESSOR OF HISTORY AT YALE, ON THE OCCASION OF THE SESQUICENTENNIAL OF TULANE UNIVERSITY, SAID THIS ABOUT THE IMPORTANCE OF UNDERGRADUATE EDUCATION TO THE UNIVERSITY:

". . . THE DIFFERENCE BETWEEN BAD SCHOLARSHIP AND GOOD SCHOLARSHIP IS THE RESULT OF WHAT WE DO IN THE GRADUATE SCHOOL, BUT THE DIFFERENCE BETWEEN GOOD SCHOLARSHIP AND GREAT SCHOLARSHIP IS THE RESULT OF WHAT WE DO IN THE COLLEGE."

THE BOUNDARIES BETWEEN TWO-YEAR INSTITUTIONS, FOUR-YEAR COLLEGES, AND GRADUATE UNIVERSITIES ARE, IN PART, SIMPLE AND NECESSARY

ADMINISTRATIVE CONVENIENCES; THEY ARE NOT IMPERMEABLE WALLS. THEY SHOULD NOT BE SEEN AS BARRIERS TO BETTER UNDERSTANDING OF THE MORE FUNDAMENTAL COMMONALITY OF INTEREST THAT BINDS TOGETHER ALL LEVELS OF THE NATIONAL EDUCATION AND RESEARCH ENTERPRISE. AS THE NEW NSF SCIENCE AND ENGINEERING EDUCATION ACTIVITY IS DEVELOPED, THE UNIVERSITIES JOIN WITH UNDERGRADUATE INSTITUTIONS TO ASK THAT THE NEEDS AND ROLE OF THE UNDERGRADUATE INSTRUCTIONAL PROGRAMS ALSO BE ADDRESSED. WE ARE PLEASED TO NOTE THAT THE FOUNDATION PROPOSES TO CONTINUE AND STRENGTHEN SOMEWHAT ITS PROGRAM OF RESEARCH AT PREDOMINATELY UNDERGRADUATE INSTITUTIONS.

GRADUATE FELLOWSHIPS

LEVEL FUNDING AT THE FY 1985 LEVEL IS PROPOSED FOR THE GRADUATE FELLOWSHIP PROGRAM. IN THE LAST TWO YEARS, SIGNIFICANT PROGRESS HAS BEEN MADE TO STRENGTHEN THE PROGRAM BY INCREASING THE STIPEND ($11,100) AND COST-OF-EDUCATION ALLOWANCE ($6,000). HOWEVER, THE PROGRAM CONTINUES TO LAG BEHIND MARKET FORCES IN THE COMPETITION FOR NEW TALENT. THE NEW DOD GRADUATE FELLOWSHIP PROGRAM OF THE OFFICE OF NAVAL RESEARCH (ONR) IS A MORE EFFECTIVE INCENTIVE FOR THE VERY BEST MINDS TO PURSUE GRADUATE TRAINING IN THE SCIENCES AND ENGINEERING. THE ONR PROGRAM RECOGNIZES THE CURRENT LABOR MARKET DEMAND FOR TALENTED BACHELORS-LEVEL SCIENTISTS AND ENGINEERS. IT SEEKS TO COMPETE FOR THOSE INDIVIDUALS BY PROVIDING STIPENDS OF $13,000 TO $14,000, FULL TUITION PLUS A SUPPLEMENTAL RESEARCH AWARD TO THE HOST DEPARTMENT. IF THE FOUNDATION WERE TO ADOPT THIS APPROACH, IT WOULD SUBSTANTIALLY STRENGTHEN ITS GRADUATE FELLOWSHIP AND MINORITY GRADUATE FELLOWSHIP PROGRAMS. THE COST OF BRINGING THE STIPEND INTO LINE WITH THE DOD PROGRAM WOULD BE ABOUT $3 MILLION; THAT OUGHT TO BE THE NEXT STEP TAKEN. A COMPARABLE INCREMENT WOULD INCREASE THE COST-OF-EDUCATION PAYMENT TO ABOUT $8,000, A LEVEL CLOSER TO PRESENT TUITION LEVELS IN LEADING INDEPENDENT AND PUBLIC UNIVERSITIES. THE PROPOSED $31 MILLION CARRYOVER FROM FY 1985 MAY PRESENT AN OPPORTUNITY TO TAKE AT LEAST ONE OF THESE ADDITIONAL NECESSARY STEPS.

RESEARCH FACILITIES

IN HIS REMARKS TO THE SCIENCE AND TECHNOLOGY COMMITTEE, DR. KEYWORTH EMPHASIZED THAT "WHATEVER FISCAL SCENARIO WE FACE," WE MUST BEGIN TO PROVIDE FOR PRIORITY RESEARCH FACILITIES WITHIN OUR R&D PROGRAMS. THE MOST SERIOUS PROBLEM NOW FACING OUR RESEARCH UNIVERSITIES IS THE NEED TO MODERNIZE THEIR RESEARCH LABORATORIES, INCLUDING BOTH THE RESEARCH INSTRUMENTATION NECESSARY FOR THE CONDUCT OF MODERN RESEARCH AND ADVANCED TRAINING AND, IN A GREAT MANY CASES, THE REHABILITATION OF THE LABORATORY BUILDINGS THEMSELVES. AT THE PRESENT MOMENT, HOWEVER, NO AGENCY OF GOVERNMENT POSSESSES A DATA COLLECTION AND ANALYSIS CAPABILITY WITH WHICH TO DOCUMENT, TO ANALYZE, AND TO BETTER UNDERSTAND THE NATIONAL DIMENSIONS OF THE PROBLEM OR THE CONSEQUENCES OF THE CAPITAL DEFICIT FOR THE NATION'S RESEARCH PROGRAMS. THERE ARE NO PROGRAMS IN PLACE OR APPARENTLY BEING DESIGNED TO PROVIDE FEDERAL LEADERSHIP. AS A RESULT, DEBATE ON THE MERITS OF THE ISSUE FREQUENTLY IS IMPEDED BY MISPERCEPTION AND MISINFORMATION.

LATE LAST YEAR, THE NSF, WORKING WITH SEVERAL OTHER LEADING AGENCIES (DOD, DOE, NIH, USDA, AND NASA), PREPARED TO CARRY OUT A FIVE-AGENCY ASSESSMENT OF THE PROBLEM; THE STUDY WAS REQUESTED OF DOD BY THE HOUSE COMMITTEE ON ARMED SERVICES. AT THE LAST MOMENT, AFTER MUCH OF THE DESIGN WORK HAD BEEN COMPLETED, NSF WAS BARRED BY OMB FROM CARRYING OUT THE SURVEY. AS A CONSEQUENCE OF THE OMB ACTION, NSF HAS NOT MOVED AHEAD TO ESTABLISH A DATA COLLECTION AND ANALYSIS CAPABILITY ON RESEARCH FACILITIES NEEDS, SIMILAR TO THE ONE REQUESTED BY THIS COMMITTEE AND NOW IN PLACE FOR RESEARCH EQUIPMENT. WE ASK THAT THE COMMITTEE DIRECT NSF TO COOPERATE WITH THE OTHER MISSION AGENCIES IN ESTABLISHING SUCH AN ANALYTICAL CAPABILITY AND TO SUSTAIN IT AS AN INTEGRAL PART OF THE FOUNDATION'S SCIENCE RESOURCES STUDIES PROGRAM.

LAST YEAR, THE AAU AND SEVERAL OTHER HIGHER EDUCATION ASSOCIATIONS JOINED WITH OTHER ORGANIZATIONS IN CALLING FOR A REAFFIRMATION OF THE ROLE OF OPEN, MERIT-BASED COMPETITION IN THE

AWARD OF FEDERAL RESEARCH RESOURCES, ESPECIALLY IN THE AWARD OF EARMARKED FUNDING FOR RESEARCH FACILITIES. AS MY FINAL COMMENT TODAY I WANT TO REEMPHASIZE OUR FIRM CONVICTION THAT THE NATION RECEIVES ITS GREATEST RETURN ON ITS INVESTMENT OF RESEARCH AND RESEARCH FACILITIES FUNDS WHEN THEY ARE AWARDED ON THE BASIS OF SCIENTIFIC MERIT IN OPEN COMPETITION AMONG ALL INTERESTED AND QUALIFIED PARTIES. AT A TIME WHEN WE LACK ORGANIZED PROGRAMS WITHIN WHICH INSTITUTIONS CAN COMPETE FOR FACILITIES FUNDING, WE ARE LIKELY TO SEE CONTINUED PRESSURE FOR EARMARKED FUNDING FOR A PRIVILEGED FEW. WE URGE THE COMMITTEE TO RESIST SUCH APPROACHES, AND IN DOING SO TO DIRECT NSF AND THE OTHER MISSION AGENCIES TO PLAN FOR AND PROPOSE FACILITIES REHABILITATION INITIATIVES BEGINNING NEXT YEAR. IN ADDITION, WE ASK THAT THE FOUNDATION JOIN WITH THE MISSION AGENCIES AND OTHERS TO FORMULATE AWARD CRITERIA AND ADMINISTRATIVE MECHANISMS FOR THE ALLOCATION OF FACILITIES RESOURCES. THIS WILL ALLOW PROMPT IMPLEMENTATION IF NEW PROGRAMS ARE APPROVED NEXT YEAR.

THANK YOU, MR. CHAIRMAN. I WILL BE PLEASED TO ANSWER YOUR QUESTIONS.

Mr. WALGREN. Thank you, Dr. Rosenzweig.

Let me ask the general question about whether or not you can share with us any frustrations you may have about the priority-setting process at NSF. We have a tradition in this area where the National Science Foundation is given great room to allocate its dollars in the most effective way, and that is certainly something that we don't want to interrupt. On the other hand, in this last year the Congress certainly led the way in more than in encouraging the emphasis on engineering, and we see a response from NSF. That came about from a somewhat constituency-based interest and drive, and then, I take it, since it has been certainly endorsed by the administration in this year's budget and certainly saluted by each of you in your testimony, that this is a good thing.

Can you respond or could you give us any of your reservations about the priority-setting within NSF as an organization and whether or not you see the Congress as being proper to try to create emphases that might not be there at any given time? Let me just give that general question, and if anybody wants to volunteer an answer, I would be interested in the response.

Dr. WHITE. Perhaps you ought to start with me since I started the testimony, Mr. Chairman.

First let me say that as a former head of an agency in the executive branch it was always very important to have the sense of the Congress, and I think it is not only proper, but the way things are done in this country. This is a negotiating society that we have, and the views of the people sitting in rooms like this, elected by the citizens of this country, should be expressing their views to the executive branch as to what they feel are important things to do. So, in my view that's a perfectly proper and appropriate thing and should be, in my opinion, welcomed by the executive branch.

The internal decisionmaking processes in the National Science Foundation, from my observation, work quite well. The National Science Board, the director and his staff do, in my observation, take into account the recommendations and views that emerge during the year both from the Congress and from other bodies such as our academies and other groups. They do have a tough job in setting priorities, and I think they must be given credit for occasionally making a tough decision with which all of us don't necessarily agree.

So, in my view, it seems to be moving in the right direction, and sessions such as this where we have an opportunity to express our views on the policies and programs are exactly what is needed to come out of the process with a budget that makes good sense.

Mr. WALGREN. Dr. Hamburg.

Dr. HAMBURG. I would like to say a word about this. In general, over the years I think that the scientific community has viewed NSF as doing a very high-quality professional job in priority setting. Dr. Stever is here today. When he was the head of the NSF, it certainly enjoyed the highest respect in that regard, and Dr. Atkinson's term, and so on. I don't have any reason to differ with what Dr. White said about that.

Let me try to spell out for a moment what I think is embedded in the decisionmaking process. The main factor, it seems to me as I have looked at it from outside, in NSF and NIH as well, is scientific opportunity. And there are serious problems of vision, how far ahead you can see within the limits of anticipation, how can you see around corners, how can you have reasonable confidence that there is or is not a scientific opportunity some distance beyond the current frontier?

Whatever the difficulties may be in that, it seems to me that the worldwide scientific community sees NSF and NIH as doing that about as well as it's humanly possible to do it.

However, in a second matter, it's more problematic and there's more controversy; and that is, how do you take into account what is, in the NIH case, the burden of illness, to what extent should the burden of illness in the country, certain common diseases, certain severe diseases that are largely unchecked, how important should that be as a stimulus to the scientific community, to what extent should you take a plunge even when you don't see much scientific opportunity but you think the weight of the illness is so heavy that you ought to try to do it.

Now, that may seem farfetched for the NSF, but not entirely. On the issue of incentive, burden of illness, burden of social need, social problem, matters that come to the Congress all the time, what people are worried about in the country, to what extent should that be a determining factor in setting priorities? My own position on that in the health field, which I know much better than anything else, is that it ought to be a very important stimulus.

The scientific community ought not to say, "We can't be concerned with that. When there's scientific opportunity, then we'll recognize it. Where there's a handle on the problem, we'll grab it." No, the diseases and the social burdens of various kinds ought to be a stimulus. We ought to be sure we have mechanisms that sort of say, "Rub our noses—the scientific community leadership—rub our noses in the problem to ask are we really searching for scientific opportunities, is it possible to conceive of a line of inquiry which would have a reasonable chance in 5 or 10 or 15 years of really making an important dent on some heavy burden that we're now carrying?"

That, I think, is the main area of controversy in science policy. My sense is that the interplay between the NSF and Congress over the years has been stimulating and constructive on that point, but I think, quite frankly, in respect to all science support, that Congress ought not to be bashful in providing that kind of stimulus to the scientific community.

Mr. Walgren. Thank you, Dr. Hamburg.

Dr. Rosenzweig.

Dr. Rosenzweig. I quite largely share Dr. Hamburg's comments and Dr. White's comments on the subject. The question isn't whether the Congress has a right to a role in the process. I suppose in some ultimate constitutional sense Congress has the right to control the process. It doesn't frequently exercise that right, for reasons of institutional humility, if you will, or self-restraint or recognition that there are lots of things to do and you can't do them all equally well.

I think that in recent years Congress and this committee have been a constructive influence in helping to develop programs in engineering and technology in the Foundation, perhaps beyond the level to which they would have grown had it not been for pressure from the committee.

I think the committee and the Congress have been a constructive influence in recent years in pushing the Foundation to develop its science education program certainly beyond what they would have been had the Congress not taken a role.

I would point out that in earlier years Congress has intervened in the science education programs of the Foundation in not nearly so benign a way, in fact in quite a malign way. There are good interventions and bad interventions, and the fact of intervention itself is neither good or bad; they ought to be tested by their wisdom, by their results, and by what one learns from them.

Mr. **Walgren**. Thank you, Dr. Rosenzweig.

The gentleman from Colorado, Mr. Wirth.

Mr. **Wirth**. Thank you, Mr. Chairman. I am delighted to be back with you after 6 years on the Budget Committee—a fate worse that I would not suggest to any of you you might want to do.

I would share all the comments that have been made about how the NSF has done a good job of setting priorities within its budget, and we're pleased to see the administration putting greater attention on research and development than it might have in earlier years, and particularly as the budget overall is in such difficulty.

I think I would be remiss, and I am sure others of my colleagues would, if we didn't put the other part of the equation in, and that's what the debate for national resources is all about—who's getting what. And we are not going to solve that problem here this afternoon, but again to remind ourselves that we're here talking about a very tight research and development budget and a very significant budget for "Star Wars." We're talking about university instrumentation, real problems. But spending money for Divad, we're talking about facilities and what's happening to science facilities, and yet we're building very significant facilities for demothballed battleships somewhere in the Gulf of Mexico.

Let's remember that these are the issues that ultimately we have to deal with in terms of national priorities, and we're all, I am sure, more than familiar with that, and that stark reality has to come back to us again and again.

I had two points specifically that I wanted to ask you about. You notice in the NSF budget there is, in effect, a recission of $31.5 million in the science education program that comes out of the 1985 budget, pushed into 1986, but in effect we have a budget in some of the most sensitive areas I think that all three of you touched upon—instrumentation, graduate student support, and the broader education role of the National Science Foundation.

Is it appropriate that such a big whack be taken in science education, or should that $31.5 million be spread across the other functions in the budget?

Dr. **Rosenzweig**. I believe those funds are being carried forward, are they not?

Mr. **Wirth**. Well, effectively, they are being carried forward, but actually what we're seeing is that kind of a cut in the current support of funding. Right?

Dr. **Rosenzweig**. Yes. My sense is that they will be used eventually. I would not—as much as I would like additional money for instrumentation, facilities and other good things that I would like to see more of in the budget—I would not myself recommend reprogramming that money to other purposes. I think they will eventually be put to good use in the area of science education and that's where they belong.

Dr. WHITE. I would support the view of Dr. Rosenzweig on that.

Mr. WIRTH. So that recission in 1985 is an appropriate one and that would go on and let that spill out in 1986 money. Is that right?

Dr. WHITE. Yes. I am not sure that it's technically a recission. I don't want to get involved in the legal semantics of what they've actually done but whatever it is——

Mr. WIRTH. That's effectively what it is.

Dr. ROSENZWEIG. Whatever it is, I think it's not an unreasonable action for them to take right now, given the circumstances they face.

Mr. WIRTH. But that does touch on the question whether they can move promptly on science education. Are we talking about cranking up something like the SDI? We're certainly not. I mean NSF has a marvelous track record in what it did in the 1960's and 1970's in science education. All one has to do is get out the files, and you'd have a major program of excellent quality.

In addition to that, if you take only the administration-initiated reports on education—say the "Nation at Risk" one had a number of distinguished scientists on it, Bill Baker and Jerry Holt and other people like that—and then of course the NSB report. Those two, particularly the latter one, the National Science Board report, have a set of recommendations, lots of new ideas in addition to the ones that you can build on from what NSF did before.

I believe an excellent program could be constructed in a matter of months. I was almost going to say weeks, but I won't be too rash. I don't see any reason why we have to be talking about the long-term future in using that kind of money for science education. It does seem bizarre to me when all three of you were talking about instrumentation, about training young professionals and so on, that we're taking right out of what all three of you touched upon, one of the most important areas of the budget $31.5 million.

I think of another one that Congressman Walgren and Congressman Judd and I had a colloquy on on the floor last year which related to the impact of television on children and the possibility of using television as a much more creative and omnipresent teaching tool. As you know, Dr. Hamburg, the more we know about television the more we know what an impact it has on kids and the more promising it is. Yet the anomaly seems to be the more we know the less we use it.

Is this an area that NSF should be pursuing or is this an area that should continue as the chairman of the subcommittee and the ranking Republican last year said ought to be a priority at NSF, or should this be chopped out?

Dr. HAMBURG. I think it's a tremendous opportunity for NSF. We've had at our Foundation two conferences that I initiated in the past few months, the second of which was last week. In each case we had an NSF representative. Dr. Shakhashiri came to the first one and one of his senior colleagues came to the second one. I have the feeling that they are keenly interested, that they really want to pursue the unfilled potential of television for education. It's simply immense.

If you think just for a moment, the AAAS has done some modest amount of joint thinking with Children's Television Workshop. There is a model there of getting the leading scientists in the country together in a continuing way with the creative people who want to make educational programs for television. That's one thing, linking that, some scientific accuracy with television creativity. And then if you take that kind of idea in the context of the research evidence that does exist of what educational impact, as you say, Mr. Wirth, the strong educational impact of television, it's really outrageous to waste it.

There is a lot of very good material, chiefly on public television, at the present time that is not readily available in the classrooms. In principle, with the spread of video cassettes, you could have video cassettes with the finest science teachers and visual displays available in this country creatively portrayed, eliciting interest from a lot of kids for whom television is the real reality and who would probably pay little attention to other sources of presentation on science.

That ought to be there. It can be there. It's not an issue of technical feasibility. And NSF has a leadership role to play. Our Foundation and others will certainly join in this enterprise to do what we can, but our scale of operation is necessarily smaller than the NSF.

Mr. **Wirth**. Mr. Chairman, I have 30 seconds remaining. I wanted to ask Dr. Hamburg about a statement on page 22 of his testimony related to our relationship with the U.S.S.R.

A year ago Congressman Ritter and others and I had the privilege of hearing Sidney Durrell testify before the Congress on the subject of Sakharov and what we should do in the United States in terms of scientific exchanges as long as the Sakharov problem remained as exacerbated as it then was. Has the situation changed so that we should now renew a number of our exchange programs with the Soviet Union, or should we maintain the pressure on the Soviets through nonexchanges?

Dr. **Hamburg**. The speech of President Reagan that I alluded to, in June of 1984, in which he endorsed the scientific and scholarly exchanges, was in a conference that we sponsored which looked at the whole range of experience we had with the Soviets from day 1 in scientific and scholarly exchanges and tried to sort out the conditions under which you can have a useful exchange, and the role of the human rights issue, which is a very important and poignant one, in those exchanges. There was some consensus which grew out of it which was strongly endorsed by the President.

But let me state my own view. One kind of exchange that ought to go forward under any and all circumstances is the kind of exchange that deals directly and explicitly with avoiding nuclear war. There, the scientific and scholarly community can play a role, has played a role, and could play a larger one. And the worse the situation is in the world the more you need that kind of exchange.

Now, in my judgment, the human rights matter becomes more difficult when you're talking about the more usual kind of scientific exchange, say, disciplinary exchanges in physics or chemistry, with the Soviets, are we going to have exchanges in physics, Sakharov's own field, at a time when he's in such poor conditions.

The prevailing view at the conference was you should go ahead and always raise the human rights issues. The last time I was in the Soviet Union on a scientific exchange I went out and visited with Mrs. Sakharov, quite visibly. The Soviets knew I was doing it. I raised the Sakharov issue with them. I went out to see her. At the same time, we went ahead with the discussions we were having in the exchange.

That is the consensus view, although there certainly are a lot of people who make a strong case for varying the amount of exchange or the quality of exchange with the human rights circumstance in the Soviet Union. It's a long, long discussion.

But in general, I think it probably is wise to pursue the exchanges, bearing national security in mind, and always raising the human rights issues.

Mr. WALGREN. Thank you very much for that exchange.

Let me now recognize the ranking member on the minority side, Mr. Boehlert.

Mr. BOEHLERT. The gentleman from Colorado has 30 more seconds if he'd like.

Mr. Chairman, thank you very much.

I would like to thank all the witnesses for their very comprehensive statements. You know, we're somewhat the envy of our colleagues in the Congress because we're partners here on this side of the table and you there, in praising basically a budget that calls for increases in some very important areas dealing with our international competitive position at a time when everybody in this town seems to be preoccupied with deficits and the debt, and the rallying cry seems to be, "Cut, cut, cut."

I am basically very pleased with this budget. For the National Science Foundation, I have some different priorities, as we all do. I would like to first of all mention that all three of you, exact quotes, Dr. Rosenzweig, you said it's a good budget; Dr. Hamburg, you said the budget is a good, strong product; and, Dr. White, you said the budget is sound and deserves support. And I am glad to see that testimony.

In the area of science education, as Congressman Wirth pointed out, this is an area that is particularly important to all of us. And when Mr. Bloch appears before us tomorrow, we're going to be talking about that carryover of funds. We sort of had the view that there was an emergency, a crisis situation in America, and that we should move with dispatch when the NSF seems to be making haste slowly.

But I am vitally concerned, and, Dr. White, in your statement on page 5, I believe it is, you're talking about a dramatic increase in undergraduate enrollments in engineering schools over the past few years. I am really concerned about this budget proposal from the administration that calls for a dramatic decrease in Federal support for student assistance programs, because I am afraid you might see a turnaround in that figure that you're lauding.

Aren't you concerned about that? Where are we going to get our future scientists and engineers if the Government of the United States is not willing to make an investment in their education?

Dr. WHITE. Well, I would have to say it's clear that we're all concerned that we maintain a high level of enrollment in our universities. I think the increase in undergraduate enrollment in engineering schools is not because of government assistance, however. It's fundamentally because engineering and technology are very exciting, there are jobs out there, there are careers out there. Youngsters are excited by this. And the reason for this dramatic increase is not because of government assistance.

So having indicated my views on that, let me say that in reference to Congressman Wirth's comment about attitudes toward science education, I interpreted his question to refer to a reprogramming of money from other areas of the National Science Foundation budget into science education. And my view is that I think this budget has been very, very carefully crafted and that I would go along with the NSF proposals.

On the other hand, I would support, as Dr. Hamburg has supported, strengthening science education whatever we can. And that may require an increase in this budget, but I would not want to see it come at the expense of the other allocations of resources in the NSF budget.

I don't know which programs of student assistance you're referring to.

Mr. BOEHLERT. Well, the Student Loan Program.

Dr. WHITE. The Student Loan Program.

Mr. BOEHLERT. That bothers me. What does it cost to go to an engineering school today, typical cost per year?

Dr. WHITE. Well, if you go to a top private school like MIT, I suppose tuition now is up around $11,000 to $12,000 plus living expenses. It would probably cost you $15,000 to $20,000 a year to maintain a student at MIT. At a State university it would be perhaps half that, I expect.

Mr. BOEHLERT. But aren't you concerned that there are children from families that are probably only making that annually that have great potential, but because we're going to change the ground rules—well, let's say it this way, the administration is proposing it, but Congress I don't think will accept it—but aren't you really concerned about that, and shouldn't you be speaking up?

Dr. WHITE. No. I have to say that I agree with you, but we're getting off the NSF budget; this is a more general question.

Mr. BOEHLERT. I understand. But it's critical. It's central.

Dr. WHITE. Sure. We're dealing with a question of assistance to students and proposals to lower the limits on the income which would qualify for student assistance. I think that's getting too low. I would like to see that higher. This is a personal view of mine. I think that the cost of university education today is such that we need to provide assistance to a larger range of income groups than perhaps is being proposed.

Mr. BOEHLERT. Dr. Rosenzweig, do you have a comment?

Dr. ROSENZWEIG. I appreciate your drawing that connection. Dr. White is quite right that the increased attractiveness of engineering as a profession isn't a function of existing student aid programs, it's because the opportunities are out there and are visibly seen to be out there on the part of large numbers of students.

But if one looked at the way those students are financing their education, I suspect we would quickly come to agreement that the Federal programs of student assistance are an important element in sustaining that increased engineering enrollment.

I think that the proposals of the administration with respect to guaranteed student loans and Pell grants and the general conditions under which student assistance can be obtained and the limits for it would be disastrous to the educational system and to the capacity in the long run, and the scientific and technological capacity of the Nation. Not the least of the problems that it would cause is a function of the apparent readiness of the administration, at least the Secretary of Education and Mr. Stockman, to face an educational system in which poor kids go to poor schools and rich kids go to good schools.

I think that's simply unacceptable. I mean that's a social policy from which we turned away 20 or so years ago, with great profit to the Nation intellectually, socially, economically, and politically. And I think it would be a disaster to turn our backs on that policy now.

Mr. **Boehlert**. Dr. Hamburg, do you have any comment?

Dr. **Hamburg**. I agree with what's been said. I would only add one additional concern which is implied in what you said, Mr. Boehlert. That is, there has been a certain amount of loose talk lately in connection with this issue that, "Well, maybe we've got too many kids going on to higher education altogether." It is true we have a higher proportion of people going on to higher education than other countries. It's been, in my view, one of the good things we've stood for in the world. It's been a point of great respect throughout the world for the United States that we do have that kind of educational opportunity.

But beyond that, from firsthand experience, I would say quite the reverse, that there's an awful lot of wasted talent in our poor communities, particularly with respect to science potential, a lot of wasted talent of people who don't get anywhere near higher education today who have the basic capacity for it. And I think we ought to be turning our great American ingenuity to finding ways to move them ahead and enrich the talent pool of the country rather than talking about how we should shrink the size of the pool for higher education.

Mr. **Boehlert**. Fine. Thank you.

Dr. White, when you talk about the serious decline in the number of Ph.D. candidates, part of the problem I think is the great opportunities you mentioned earlier; a young undergraduate engineer today is probably commanding a $30,000-a-year starting salary and it's kind of tough to say, "Well, I'll defer that starting salary for 3 or 4 more years while I continue my studies."

It's serious, but what are the long-range implications of so many deciding not to continue their studies and going right out and making the big buck initially?

Dr. **White**. Well, we're going to lose the talent that needs to be trained through the level of Ph.D. and beyond, and that is the corps of individuals who will be able to keep this country at the technological cutting edge.

Mr. BOEHLERT. So how best do we turn it around?

Dr. WHITE. That's the trick we have to turn. It seems to me there are some elements in the NSF Program, such as the Presidential Young Investigator Awards, which are very important in doing that. It seems to me that we need to provide more attractive possibilities for faculties of universities. This means funding research support has to do it. It's not an easy job to do, but that's the trick that's got to be turned.

Mr. BOEHLERT. The young investigators in engineering. Let's see, we have 250 called for in this budget. How does that compare with our competition in the world? What are the Japanese doing in this area, for example? Do you have any information on that, or on the West Germans?

Dr. WHITE. Well, the Japanese are training a great number of engineers, of course, and it's a matter of concern. We are in a rough supply demand balance at the baccalaureate level as I understand it, except for a few areas like electronics and computer engineering. But we have now moved to a point where the supply being turned out out of our universities at the baccalaureate levels is about meeting demand except in a couple of fields.

Where we're really in trouble is at the graduate level, and this is where we've got to focus our efforts. And that was the thrust of my testimony.

Mr. BOEHLERT. All right. All three of you—and this will be my concluding question now—we're dealing with a budget we all agree is basically a good budget and one that should be supported, the budget request for NSF. Pinpoint individually, if you will, the greatest deficiency you see in the NSF proposed budget, one area that you would change and give greater emphasis to. Dr. Rosenzweig.

Dr. ROSENZWEIG. Can I have two? [Laughter.]

Mr. BOEHLERT. Yes; you can.

Dr. ROSENZWEIG. Thank you. I would like, if I had been making up the budget, I would have put, I believe, more money into graduate fellowships.

In addition to that, and utterly trivial in terms of the total, I support David Hamburg's comments on behalf of the EVIST Program. I think it's a useful, important program both substantively and symbolically. I've taken part in one of its programs over the last year. I think it's been an excellent one, good experience for me and for everybody else, and will have useful results beyond those who actually took part in it. I think it's a good investment.

Dr. BOEHLERT. Thank you.

Dr. Hamburg.

Dr. HAMBURG. Since we've covered science education and our concern about that, then I will just reinforce EVIST.

Mr. BOEHLERT. Dr. White.

Dr. WHITE. I would have to say the undercapitalization of equipment and instrumentation. I believe that more needs to be done there.

Mr. BOEHLERT. You've got an ally, Congressman Brown up here, and I am very supportive, too.

Mr. WALGREN. Let me then recognize Congressman Brown.

Mr. BROWN. I think we've all recognized the fact that we do have a reasonably good budget, considering the constraints that we have, and we're going to have to find some fairly strong reasons to do much tinkering with it.

But it seems to me, if I might respond to Mr. Boehlert's question, I think it would confirm the shortage in the instrumentation and in the facilities area. I wanted to raise the question with all of you, and Dr. White in particular—if there are any new and innovative ideas about how we could help to solve this problem, which looks to me to be several billion dollars in scope, by resolving it in some way other than relying entirely on some sort of a granting mechanism, which of course everybody would feel would be the best from the standpoint of the universities, but we may have to look at something different from that.

I wonder if, within the university community, there has been any analysis or effort to see if there are some other ways in which the Federal Government could play a role that didn't involve the direct granting of large sums of money which we're just not going to have available right away.

Dr. WHITE. Yes; there are. And I think this is really where one of the major pushes has to come in dealing with the equipment and instrumentation problem. We generally tend to think of Federal funding——

Mr. BROWN. I am sorry, can we distinguish between equipment and instrumentation and laboratory facilities themselves?

Dr. WHITE. You mean the buildings?

Mr. BROWN. The buildings.

Dr. WHITE. Yes.

Mr. BROWN. Those are two separate problems? OK.

Dr. WHITE. They're two separate problems, but sometimes they go hand in hand.

Mr. BROWN. Yes.

Dr. WHITE. My comment will apply to both of them. I have been involved in previous posts that I have held in activities which generally come under the rubric of creative financing, where you do not seek to acquire equipment and facilities by direct "on-budget" appropriations, which is the typical thing that we are talking about, but where through the cooperative activity of the government, the private financing sector, and an institution wanting a facility or set of equipment, it is possible with very modest appropriations on the part of the government to actually build and acquire very, very large facilities.

We did this when I was head of the National Center for Atmospheric Research in Congressman Wirth's district in Boulder, CO. We acquired a Cray computer costing $20 million by arrangements with the city of Boulder, the University of Colorado and the National Science Foundation. The requirement on the part of the government was to put up essentially an appropriation each year which carried the operating costs of the facility.

It seems to me that there are a lot of other approaches which are now being investigated in the university community which look at different ways of financing major items of equipment and instrumentation and facilities, and I think we ought to look at these approaches very seriously as one way of dealing with the problem without having the direct onbudget appropriations required for them.

And perhaps some of these other gentlemen might wish to comment on that.

Dr. ROSENZWEIG. I think, Mr. Brown, that one way or another the Government is going to wind up paying a large part of this bill——

Mr. BROWN. Of course.

Dr. ROSENZWEIG. Either by grant, probably matching grant, or in some other form. What's happened over the last 10 to 15 years is that most of the facilities that have been built on university campuses have been built either with State funds or with private gifts or with borrowed money or, more often, some combination of those three. As a consequence, interest charges and use charges, which formerly were not chargeable to the overhead rate on grants and contracts because the facilities were, in part, federally financed, are making their way into the indirect cost rate and causing a substantial increase in the indirect cost rate, with lots of attendant problems, as you well know.

So in that sense, those facilities which are privately financed or State financed are at second remove being financed, in part, by the Federal Government. Much better in my view to do that directly, make conscious budgetary decisions and conscious programmatic decisions, and spend the money up front rather than at one remove and in a way that causes maximum divisiveness between scientists and their institutions.

Mr. BROWN. Well, what I am looking for is something we can do in this bill which will move us in the direction of solving the problem but won't cost us a lot of money. For example, I was a little surprised to find that we have a fairly good handle on the amount of unmet needs in laboratory equipment and facilities but very little in the way of buildings—instrumentation I guess is what I should say. We know what the shortages are in instrumentation and laboratory equipment, but not in the buildings themselves, which I guess is the facilities part.

Can we put something in this bill which would mandate NSF to begin a process of getting that kind of information, or could we put something into the bill that would mandate the exploration of, let's say, long-range capital budgeting which might be an improvement over what we're doing at the present time in this area?

Dr. ROSENZWEIG. I have no doubt that you can in both instances, and I hope that you will in both instances.

Mr. BROWN. Would you agree with that, Dr. White?

Dr. WHITE. Yes, I would agree with that.

Mr. BROWN. All right. One other area I wanted to touch on briefly—and you spent some time on that, Dr. Hamburg, and some of the others of you did, and Dr. Stever in his testimony, which I have already read, commented on it also—and that is our role in international science and the fact that we have some deficiencies in what's happening as far as the NSF is concerned. I am deeply concerned about the fact that our most prudent course in the world today would probably be assisting with the development of improved research and development in the developing and underdeveloped nations, and yet our role there seems to be declining as well as our role in science exchanges with the Soviet bloc, for example, although that seems to be moving upward a little bit at the present time.

And I am deeply concerned about what would be an appropriate and, again, not too expensive way to reaffirm the importance of this in connection with this legislation.

Dr. Hamburg, you spent the most time on this, I think.

Dr. HAMBURG. I would like to speak to that.

Mr. BROWN. You mentioned $1 million for IIASA, for example, I think.

Dr. HAMBURG. The particular point I would like to emphasize here is what's happening in Africa. The American people have really been moved by the drought and famine in Africa, especially seeing it coming into the living room on television, and we are responding most generously as a nation in food aid.

But I think what the scientific community can address is what about long-term scientific cooperation. The first thing that you need for that, in my judgment, is to have a set of cognate institutions instead of counterparts here and there that can work together in a dependable way over the years even in the face of a coup d'etat here or a debt crisis there.

To that end, the AAAS has supported two meetings in the past year, most recently in December, with bodies from all over Africa that are either like the AAAS or like the National Research Council; that is, some kind of national or regional bodies. Mind you, they are very small, for the most part; they're nascent, they're emerging, they're rudimentary in many parts of Africa. But they are talented people. They're dedicated people.

And we're looking at the question of how you can build a kind of a core infrastructure for science. We're looking at their distinctive needs in a country or region, looking at what kinds of scientific opportunities they might have there that could have economic benefit in their country, not to develop a huge scientific establishment like we have, but there is the possibility of our basic scientific organizations working with theirs, helping to build theirs in a way that could give them a capacity to tackle their own problems.

The most vivid and poignant place to do that is in agriculture, and there are some specific things to be done. I don't want to talk at greater length about it, just to say that I think there is an approach. I don't think that the Government really has a highly coordinated approach. One hears a lot of complaints—maybe they're not justified—about the extent to which AID cooperates with scientific agencies. AID has some intrinsic scientific strength and interest, but there seems to be some friction, some difficulty in getting a coordinated approach.

I would think that the Government really could—the great Government science agencies—could give a higher place on their agenda to that kind of issue. We could carry on at greater length, but I had better not.

Mr. BROWN. Well, I was tremendously impressed a year or so ago in visiting India to see the progress they've made in agricultural research. As a result, the establishment within the last generation of a couple of dozen high-level agricultural research institutes. In all of Africa I think there are maybe two or three. And Africa represents a much more diverse problem from India, from my limited knowledge of it.

I would like to see some NSF responsibility for analyzing this problem at least and seeing if there isn't some focus we could give to what our AID Program is doing, what our Agriculture Department is doing, what the international organizations are doing, so that we could see it as a whole instead of in a bunch of little pieces. Is that a reasonable approach?

Dr. **Hamburg**. It certainly is. I think that the NSF could provide the kind of leadership that probably no other agency could. The NSF has had strong traditions in the international field, for one thing. It has ready access to the scientific community, for another thing. I believe that it could provide the intellectual firepower, the analytical skills to make sense out of what a development strategy ought to be and the role of the U.S.-LDC cooperation ought to be.

Mr. **Brown**. Thank you.

Mr. **Walgren**. Thank you, Mr. Brown.

The gentleman from Pennsylvania, Mr. Ritter.

Mr. **Ritter**. Thank you, Mr. Chairman.

I would like to ask a couple of questions. But the first one deals with some information coming out of Dr. White's testimony. It mentions that undergraduate enrollments are way up, yet there has been a longer range and serious decline in engineering Ph.D. students, particularly if one considers the ratio of U.S. citizen students to foreign students, and that we perhaps bemoan the fact that there is a 3.5 percent increase—I think Dr. Hamburg mentioned that—in support for graduate students.

I am getting some conflicting views out there, outside of Capitol Hill. On the one hand, I am getting some views from university officials, university presidents, that the relative gap between graduate student present-day graduate student salaries, stipends, assistantships, whatever, and relative to the reward that that person would get in industry, that that ratio has actually declined over the years. Back in the late 1960's, the early 1970's, the stipend over the industrial reward was higher then than it is today. The gap between the stipend and the industry salary was less then than it is today, and that somehow this is responsible or, in large part may be responsible, for the lack of engineering Ph.D. enrollments.

On the other hand, industry and the marketplace is telling us that the differences between starting salaries—and I think we have to be very careful about this because certain fields have wide differentials and others don't—but in the main, out there in manufacturing America and industrial America, the differences between the starting salaries is not that great. And one may talk about a $25,000 to $26,000 starting salary for a bachelor's in engineering and then talk about a $35,000 to $36,000, $38,000 salary for a Ph.D., eliminating some of the more sophisticated advanced electronic fields where the knowledge frontier has been rocketing outwards.

Well, I think that's a signal to students. I also think that if you extrapolate out 5 years and 10 years and you find that the bachelor student in engineering has achieved a management position and is moving upwards within the hierarchy of the company or is advancing in the Ph.D. level—the system doesn't necessarily advance the

Ph.D. person outside of the laboratory, and the data is there for these people to see because they can see people ten years out and 5 and 10 and 15 years out—but I think those are signals to people, particularly U.S.-born citizen engineering students, who might wish to go on but take a look at what the market is saying.

But there is also the opinion out there in industry that the Ph.D. program has become, to some extent, in many different disciplines, an engineering science program. They're seeking industrial competitiveness, they're seeking productivity gains, they're seeking a variety of inputs to their system which basic engineering might apply more readily than engineering science. At least this is part of the perception.

And so that again adds to the perhaps lesser differentials which are market signals which are then picked up by the undergraduate engineers who go into industry instead of going on.

I would like to get some comment from you gentlemen on this subject matter, how you see it playing out.

Dr. **Rosenzweig**. While Dr. White, who knows more about this subject is gathering his thoughts, permit me to make an observation. I think that's an extraordinarily interesting set of observations. You've identified a number of tensions that have run through, one might say, the whole history of relations between universities and the larger economy for a long time.

My sense is that when a youngster decides to start toward a Ph.D. rather than to move out of school and take a job immediately in industry after a bachelor's degree, he's taken the first step on a career line. And so you have to ask yourself what is it that moves people from one career to another. And I think the answer is certainly partly money.

Mr. **Ritter**. Well, if I may interrupt.

Dr. **Rosenzweig**. Yes.

Mr. **Ritter**. At this moment, that certainly doesn't hold true for the medical profession, and it doesn't hold true for the legal profession where people are somehow coming up with extensive loans to underwrite their entry into law school or medical school.

Dr. **Rosenzweig**. Actually, medical applications and law school applications are both going down, primarily perhaps or probably because——

Mr. **Ritter**. Oh, you have to be careful on that one, too, because there are some signals coming out of the marketplace as well.

Dr. **Rosenzweig**. Yes. No, I agree that the market signals are very important, but I think that the totality of the career opportunity is even more important, unless the economic differentials are so great that they simply overwhelm other considerations.

My sense is that a lot of youngsters have looked at the career and scholarship in science and engineering and what they've seen in recent years is that employment opportunities have been uncertain, research opportunities have been uncertain, grant funding and contract funding has been up and down in engineering, instrumentation in university laboratories is well behind instrumentation in industrial laboratories. And so the whole setting in which the individual's career is going to be played out has become over time less desirable in the university than it has seemed in industry.

There may be some signs that that's shifting. I don't know but——

Mr. RITTER. I might add that that's a very interesting observation and one worthy of some expansion. The fact is that it used to be that while the university was the place to develop your research capabilities and to get into the purity of the field, well, everybody in this room knows the vast quantity of time spent by the professoriate in accessing this Federal R&D economy, or any R&D economy, for that matter. And certainly, your institutions are proof positive.

Dr. ROSENZWEIG. Yes.

Mr. RITTER. I would like to get Dr. White's view on this.

Dr. WHITE. Well, I think the question you raise is indeed a puzzle. And I don't know that anybody has the answer, but I will give some comments. I think that people generally don't look too long into the future. I mean they look at their immediate needs. And given the high salaries being offered, you take a youngster just getting out of school, he's very much attracted to that. I don't think there's any great secret beyond that.

I think that there is also an observation that an engineering career in many cases can lead you into management positions which represent very, very good career opportunities. And management in industry doesn't necessarily require a degree at the Ph.D. level. In many cases, management in industry just requires a person who is very knowledgeable, can deal with the engineering and technical problems which he faces, but has other capabilities. Many of these youngsters then go on to business schools and other places and become broader individuals and make a career in the management channels of industry.

I think I don't know what the solution to the problem is. Obviously, the market has to place a much higher value on that Ph.D. degree. Now we see that happening. I think that situation is beginning to change. As the relationship between new products, commercialization of products, now depends upon people who are very, very knowledgeable and can operate at the cutting edge, who have a much deeper appreciation of science and engineering, I think that is now beginning to change.

Mr. RITTER. If I could interject here, I think that's right. I think to the extent that the Ph.D. programs are rooted in a Federal R&D economy, they will be less attractive to the marketplace and to industry as opposed to—and these are broad characterizations, and I understand that—as opposed to their being rooted in an R&D economy that has more focus toward problems of industrial competitiveness and commercialization and, as you say, cutting-edge information. Perhaps the overfocus for decades on what the Federal Government, dealing with its constituencies in the national laboratories and the universities came up with as research fields and priorities and areas, perhaps that is less attractive to the marketplace than some system of formulating topics that's more steered by the private sector input to the system.

Dr. WHITE. I think there's another factor at work here that we need to pay attention to. Take the area of manufacturing. Manufacturing engineering has not generally been highly regarded in industry until very recently, where it's now become the touchstone of productivity and really the basic area in which the competitive struggle is being waged. Manufacturing has generally been regarded as sort of a second-class kind of an activity. Engineers generally don't want to go into manufacturing. And I think that there is a turnaround, but what we need to do more of is to begin to raise the appreciation, prestige and importance of some of these fields that up until now have not had that kind of attention.

Mr. **Ritter**. I think the market again——

Dr. **White**. Is now changing.

Mr. **Ritter** [continuing]. Is changing, and I think it's instructive that these manufacturing science programs which universities are proud of that have developed over the last several years are 20 years too late in some respects when you compare us with our leading competitor, competitors like Japan and Germany, and as that shift comes about and as those Ph.D. programs shift into areas that are more interesting and as we deal with industrial competitiveness, the global economy, commercialization, the cutting edge of information that helps to get products moving, the entrepreneurial revolution that's going on, I think you'll see that the differentials will once again be sufficient enough to attract the U.S. citizen into the graduate student program.

But given the current differentials, I think it's whistling Dixie to think that somehow a student who, you know, is going to sacrifice 6 years of moving up that ladder—and you know how professionally oriented today's student is, how advancement-oriented today's engineering student is, and I think that relates very directly, too, to the problem of engineering faculty—similar perception out there in the marketplace and on the part of the student body who would perceive that—that would be a field to go into as opposed to going into industry.

I have just one small question, and that is, policy research and analysis is an area that has taken about a 50-percent cut. It's a small area, but many people believe a very dynamic one, particularly in the area of trying to more scientifically assess hazards and risks. The only fundamental work that's been done on behalf of this Government in the area of risk assessment, risk analysis, has come out of that NSF program.

I was not here in what they called the climate hearings—was that how they characterized those, the climate hearings at which Dr. Bloch testified?

Ms. **Bach** [council for the minority]. The posture hearings.

Mr. **Ritter**. The posture hearings. But I understand that Dr. Bloch mentioned what scientific policy can do with 50 as opposed to 100 studies. I just wondered where those cuts were going to come and in which of the subfields of policy research and analysis. But are any of you concerned with this area being so substantially reduced? Dr. Hamburg?

Dr. **Hamburg**. I am. I should have mentioned it. It does seem to me that we very badly need to increase our analytical power in the policy-related area.

Mr. **Ritter**. Analytical power, did you say?

Dr. **Hamburg**. Analytical power, yes. And the risk assessment work is a good example; work on decision theory is a good example. NSF has supported important work that moves us, albeit slowly, toward a greater capacity to analyze complex issues systematically, move us toward objectivity and away from polemics. That seems to me very important.

I would think that at a minimum that they might want to do what Mr. Brown was suggesting with respect to international science, namely to have a look at the field, take some kind of assessment where the field is of science underlying policy studies, and be very careful that we're not just walking away from it because policy somehow is controversial.

Mr. RITTER. It seems odd that in the middle of the Federal Government seeking to establish a risk base health safety and environmental standard-setting process, and EPA coming out with some very major work in this area, and Ruckleshaus, before he left, dealing with an intergovernmental group, interagency group in this area, that the one portion of the Government that is doing significant research in this area is so strongly reduced.

I know NAS has been very active in this area. I am not sure what kind of engineering they have——

Dr. WHITE. I just don't know enough about the implications of the reduction in the policy analysis area to be in any position to comment on what the implications are.

Mr. RITTER. I thank the chairman for his indulgence.

Mr. WALGREN. Thank you, Mr. Ritter.

Well, on behalf of the committee let me express our appreciation for each of your contributions. We appreciate your participating in this process and look forward to talking to you about it as it goes on. Thanks very much.

At this point I want to call, and insert in the witness list, the Honorable Bob Edgar, who represents the congressional district around Philadelphia.

We appreciate your making yourself available to the committee. I know that it's difficult to fit these things together in terms of time.

So let me just say by way of introduction to those who might not know Bob, Congressman Edgar has been in the forefront of Members of Congress that have been reacting to the downward trend of economic activity in the Northeast, has been chairman of what's known in the Congress as the Northeast-Midwest Coalition, and also is heavily involved in that organization in the Congress that tries to do something about the future. We have a Clearinghouse on the Future that tries to take a longer look at trends in our society in hopes that we can improve the situation around us that we see that really is difficult.

So with that as background, welcome to the committee, and we appreciate your coming.

STATEMENT OF HON. BOB EDGAR, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF PENNSYLVANIA

Mr. EDGAR. Well, thank you, Mr. Chairman. I want to thank you for inviting me today to testify on the health of the Nation's science and technology base. And as you indicated, it's a merging together of my interests not only as past chairman of the Northeast-Midwest Coalition, which I am cochairman of, but also my interest as chair of the Clearinghouse on the Future, because this is in fact a foresight hearing overseeing not only the immediate budget but looking into the future in terms of its implications.

Particularly, I am interested in focusing in on the National Science Foundation's budget for its implications in relationship to the future.

It is indeed fitting that this committee begins hearings this week on the Foundation's budget. As you no doubt are aware, this is the National Engineers Week and as the week comes to a close, I feel that I will have almost been ordained a second time, this time as an engineer. I have spoken on several occasions and given testimony in several committees on issues relating to science and engineering. For, in addition to my testimony here today, last week I participated in kicking off National Engineers Week in Philadelphia, and this Friday I will be speaking back in the city of Philadelphia to the American Society of Civil Engineers.

I must admit that I decided only late last week to seek an invitation to testify before your committee. What prompted my seeking this invitation was that on Friday afternoon I stood on the steps of the Westinghouse plant in Lester, PA, where the local union, Local 107, was listening to management announce that they had made a decision to close the doors of the Westinghouse plant in Lester over the next 2 years forever. After nearly 70 years in the power generation market, management told 1,200 stunned workers at its steam turbine plant that the facility would begin shutting down.

After many successes, beginning at the time of the First World War and including such high-profile projects as the mirror structure for the Mount Palomar telescope, the propulsion component of the U.S.S. *Nautilus*, and the world's first nuclear submarine, and more recently, the locking platform system for NASA's space shuttle program, there no longer will be a Westinghouse presence in the small community of Lester.

Mr. Chairman, there are many Lester plants out there, not only in our own State of Pennsylvania but also around the Nation. We have all seen them. And there will be many more in the future unless we address the Nation's crumbling manufacturing base and crumbling manufacturing infrastructure. The human dimensions of this decline are staggering.

Lost in the welter of last year's post-election hoopla was a study released by the Bureau of Labor Statistics. The study is perhaps the most complete one yet done on displaced workers. And it really is the first time the administration itself has admitted the depth of the problem. The Bureau did a special study of workers whose jobs were abolished or lost as a result of plant closings between January 1979 and January 1984. The study shows that of the 5.1 million workers who had been at the job at least 3 years before they were displaced, about 25 percent, an astonishing 1 out of every 4 workers, were still looking for work, and an additional 15 percent had left the work force either because of retirement or discouragement.

Further, the chance of reemployment for these displaced workers declined significantly with age. For example, only 41 percent of those age 55 to 64 found jobs.

Also significant was that almost one-half of the workers in question had been displaced from jobs in the manufacturing sector, primarily in durable goods industries. In our own area, Mr. Chairman, Pittsburgh, and your own area, two out of every five factory jobs that existed in 1979 don't exist today.

A partial response to our declining industrial leadership, and the reason I am here today, is to support a significantly expanded effort in the National Science Foundation to couple university and industry engineering research and education, particularly in manufacturing technology. I am particularly interested in such an effort directed at so-called mature industries—steel, textiles, automobiles and the like.

The research needs of these industries often get overlooked in the rush toward support for high-glitter emerging technologies. Mr. Chairman, there are many problems affecting our future industrial competitiveness. There are no easy solutions, but this partial response, an expanded effort in Federal support of university-industry engineering research centers, is within our grasp.

There is $25 million requested for the National Science Foundation's fiscal year 1986 budget for these centers. This seems like a minimum effort, and it appears it could be at least doubled. This expanded effort would be more in line with the recent recommendation of the President's own Commission on Industrial Competitiveness.

I am testifying today on behalf of expanded support for these centers because National Engineers Week could not come at a more opportune moment. As the debate of this year's Presidential budget opens and proceeds over the coming months, I hope we look carefully at efforts such as the engineering research centers whose support in times of budget constraint is so fragile.

If we are being asked to increase our commitment for the Defense Department's R&D effort by over $7 billion, reaching a total of almost $40 billion, we can certainly afford to expand our support for engineering cooperative research efforts between universities and industry that will benefit us for generations to come.

If we are being asked to spend billions more for star wars research, we can certainly afford to spend additional millions for a program that is very fundamental in the way it contributes to the first line of our national defense. For while we may face threats to our national security and hostile environments from external enemies, we must not forget that the challenge to our long-run industrial competitiveness is no less a threat to our Nation.

A recent Library of Congress study calculated that only three-tenths of 1 percent of the Federal R&D is directed toward needs of civilian industry. By contrast, that figure in Japan and West Germany is 12.5 percent. We will never meet the next plateau of knowledge in technology with such a meager effort as this.

In conclusion, I want again to thank the subcommittee for extending this invitation for me to speak and specifically for its efforts to support the engineering research centers.

I might say, in earlier questioning George Brown evidently raised the issue of the infrastructure questions relating to research and technology and talked just briefly about the issue of capital budgeting. It occurs to me that as your committee looks at this question of how to bring a better partnership between industry and academia and looking at research in basic industries, that we have to look at ways to fund the capital infrastructure of that research and of those industries in some new ways.

Congressman Bill Clinger and I worked very hard last year to force the administration in accepting a piece of legislation to move the Nation a little closer to at least a capital evaluation in its budget process. We have the results of that, and the Office of Management and Budget is now doing a national facilities assessment and beginning to move us in looking at our infrastructure needs nationally for bridges, roads, water and sewer systems. And I think as we look at this area of research, we ought to also look at ways to put our infrastructure in place, our capital items in place, in a way that we pay both interest and principal over the life expectancy of those items. I would be glad to work with the committee in that regard.

Mr. Chairman, I am ready to take questions at this time.

Mr. WALGREN. Well, thank you very much for that contribution. I think it's a particularly apt one to have in the record because the sensitivities of a congressman are often different from the perspectives of academic people and people who are totally involved in science on a day-to-day level, and I think we do see that there are human beings involved on the other ends of these downturns, and we hope that some contribution can be made even though, as you say, it's only a partial response.

In Pennsylvania we have a State-funded program that we see bits and pieces of, but I think at this point the gleam is more in the eye of the beholder than the reality of university-industry centers, at least in terms of delivering new products and actually delivering new people or training people to our industry.

Is there any comment you can give on what you've seen in Pennsylvania in terms of university-industry collaboration?

Mr. EDGAR. Well, our State has done a pretty good job of identifying its major academic institutions that have expertise and skills related to some of the basic manufacturing, and we've begun I think what could be described as a first step in putting those research facilities to work at some of the basic industries. But I don't think we've gone far enough. There's been limitations of funding, and particularly in those States like Pennsylvania and Michigan that, while the rest of the Nation was in recession, there were pockets of real poverty and distress and depression in parts of Pennsylvania.

State government just simply couldn't afford to fund as adequately as I think they should have some basic research in the area of trying to deal with our declining manufacturing base and helping that manufacturing base slow its decline and perhaps retrain and reskill its workers to do existing tasks as well as new and expanding tasks. We just have not had the resources to do that as adequately as we can, and I think a Federal commitment in this area would be helpful.

Congressman Bill Gray from Philadelphia gave a great illustration when he accepted his responsibility as chair of the Budget Committee and he told the story of the little kid who falls into the well and his mother gets panicked and runs out of the house, sees the young boy's plight, and rips down a rope off the clothesline and throws it in the well. And the rope is too short, can't reach the little boy. A neighbor comes along with a longer rope and throws that into the well, and again the rope is too short. And finally, a passerby comes along with a third rope and throws it into the well and it's still too short. And while the mother and the neighbor and the passerby are looking into the well, a little voice comes out of the well saying, "Tie the ropes together."

I think our process here and the discussion that you're having in terms of the National Science Foundation, universities, industry, government, is to figure out how to tie our ropes together and really make the connection so that we're stronger as a nation. And I would hope that as a result of your hearings, as a result of appropriation action, as a result of budget action, we can use a little bit of funding, in the millions rather than in the billions, in the millions of dollars to be a catalyst to stimulate that process of tying those ropes together.

Mr. WALGREN. You know, I have to confess to some relatively partisan bitterness in that I really don't see why the bottom had to fall out in 1980. And if you graph things like the decline in the manufacturing balance-of-trade, there's a free fall that begins in 1980, and I mean literally an angular change in that graph that could be described as nothing but a free fall. And as you indicate in your testimony, almost 40 percent of those workers are still out there with absolutely no pickup in this society at all.

I hope that we can make some small partial contribution through the hopefulness that we take from these kinds of efforts, but if my friend from New York would indulge me as the father of twins, there's another story that may be more apropos about the situation we find ourselves, and that was, the fellow, the psychologist who was doing research on twins, and there were these two, and one was an inveterate optimist and the other was a terrible pessimist. And they couldn't explain, because for all practical purposes they were identical, they had the same genetic background, they had the same family upbringing. And so they were doing testing on these twins, and they put the pessimist in a room full of toys and they put the optimist in a room full of horse manure. And they came back an hour later, and the pessimist had thrown all the toys to the four corners of the room and was sitting in the middle bawling his head off. And they looked in on the optimist and he had a pitchfork and he was going at this pile of manure and he said, "There must be a pony in here someplace." [Laughter.]

Mr. WALGREN. Well, when I see the partial solutions that we have and the hope that we have to hold out for them, I often think that we're really shoveling at the manure hoping that there is a pony in there someplace.

Well, let me turn to my friend from New York.

Mr. EDGAR. We could always turn off the lights and grow mushrooms. [Laughter.]

Mr. BOEHLERT. I did a quick check of my history book over here, and you said you confess to partisan bitterness over the bottom falling out in 1980. I checked my history book to see who was in charge in 1980. And unless my history book is wrong, my party wasn't.

But as long as it's a continued story, however, let me tell you about Sir Winston Churchill, who said, "A pessimist is someone who sees danger in every opportunity, where an optimist is one who sees opportunity in every danger." I would suggest that our witness here is an optimist because you see the danger of underfunding a program like engineering research centers, and I want to assure you that the figure proposed in the NSF budget, at least from this Member's standpoint, is the starting figure. I think if anything we'll see movement upward, because I would quite agree as a fellow Northeasterner who shares your concern for areas like we are privileged to represent, that more has to be done. And I want to commend you, Mr. Edgar, for your leadership in the coalition.

I was pleased to note, as we are going through your testimony and about the problems facing some of the displaced workers, that we are identified with a piece of legislation, far removed from this committee but dealing with establishing a program of individual training accounts.

I just would like to thank you for a fine statement. You pinpoint an area that exposes some real dangers for the future of America, and I suggest that we have the opportunity to address those dangers, and that I, too, would like to prevent the Lesters of tomorrow.

Mr. **Edgar**. I appreciate that. Let me just close by making this comment. The chairman and I had the privilege of being out in Scottsdale, AZ, recently at a conference. You were there as well. But we had an opportunity to sit down with about 31 chief executive officers and 31 college presidents and maybe 25 to 26 Members of Congress and talk about research and development, talk about international competitiveness, talk about our ability to be in these areas.

You know, I can, as one Member who was there, tell you that I learned some things about the difference between basic research and applied research and development and dividing up that puzzle a little bit and understanding what our problem is. And I have got to say that we've got to stay real clear as to the importance of this basic kind of research and applied research here in the United States so that we can deal with some of these international problems, because as the chairman indicated, the trade deficit is upon us and is astronomical.

Our Clearinghouse on the Future did an estimate and discovered that perhaps as few as 10 percent of our work-force will be in heavy manufacturing by the year 2000 at present rates of development, 3 percent or less will be in agriculture. That means 87 percent of our population will be doing something else, small manufacturing, information service. And I think there is a responsibility of the Federal and State government to do what it can through its research arms and through combination of industry, academic research, to see whether or not we can't build a better society that doesn't destroy some of the basic components that we need for our national security both in terms of quality of life and in terms of our external defense.

Mr. **Walgren**. Well, thank you very much, Bob. We appreciate your coming to the committee.

And I want to be sure that I am not misunderstood. In my view, the whole NSF budget is the pony in there someplace and it's this overlay that we've got to work our way through. [Laughter.]

OK. Let's turn to the last panel, and I want to express our appreciation for their patience. Dr. Guyford Stever, who is president of Universities Research Association, comes to us with such a wealth of experience, not the least of which being the president of Carnegie-Mellon University at a very important time in the development of that university's capabilities, and also the director of the National Science Foundation at an earlier time, and the President's science adviser.

We really appreciate your making yourself available to us.

Joining Dr. Stever is John Sloane, who is the vice president for engineering with the Aluminum Co. of America, who can give us a perspective on the engineering component of this budget that is very well grounded in view of his responsibilities for one of the most extensive and wide-ranging engineering activities in the private sector that exists out there.

So welcome to the committee, and let me again say that your written statements will be made part of the record. Feel free to be as loose as we are in summarizing or communicating however you would like to.

Dr. Stever.

[The biographical sketch of Dr. Stever follows:]

Dr. H. Guyford Stever

Dr. H. Guyford Stever has had a career as a scientist, engineer, educator and administrator. He is presently a corporate director, trustee, and consultant to industries, universities and government. Among his directorships are those of TRW Inc., Schering-Plough Corporation, and Goodyear Tire and Rubber Company. He currently is President of Universities Research Association. He is a Trustee of Woods Hole Oceanographic Institute and of Science Service.

In 1976 and 1977, he served as Science and Technology Advisor to President Ford, Director of the White House Office of Science and Technology Policy, and as a member of the President's Commission on Science and Technology. From 1972 to 1976, he was Director of the National Science Foundation, and, additionally from 1973 to 1976, Science Advisor to Presidents Nixon and Ford.

Prior to his government service, he was President of Carnegie-Mellon University from 1965 to 1972, during which time the Carnegie Institute of Technology and the Mellon Institute were merged. He was Professor of Aeronautics and Astronautics at Massachusetts Institute of Technology for 20 years, as well as Head of the Departments of Mechanical Engineering, and Naval Architecture and Marine Engineering.

Dr. Stever was Chief Scientist of the U.S. Air Force in 1955 and 1956. During World War II, in 1941 and 1942, he taught and did research in radar at the MIT Radiation Laboratory, and from 1943 to 1945 he was scientific liaison officer in the London Mission of the Office of Scientific Research and Development.

He is a member of the National Academy of Sciences, the National Academy of Engineering, and the American Academy of Arts and Sciences, and a fellow of the American Physical Society, the American Institute of Aeronautics and Astronautics, the Royal Aeronautical Society, the Royal Society of Arts and others.

He has authored many publications and lectured widely. He has received the President's Certificate of Merit, the Commander, Order of Merit of Poland, the Distinguished Public Service of the Department of Defense, and other honors.

He holds an A.B. from Colgate University (1938), a Ph.D in physics from the California Institute of Technology (1941), and numerous honorary degrees of D.Sc., D.Eng., LL.D., D.Hum., and D.P.S.

STATEMENT OF DR. H. GUYFORD STEVER, PRESIDENT, UNIVERSITIES RESEARCH ASSOCIATION

Dr. STEVER. Thank you very much, Mr. Chairman. It is an honor to be with you.

I have sat in this chair quite often testifying to you as the Director of the National Science Foundation, but this is the first time in my experience that the people on both sides of the chair said, "Well, there isn't much that we can complain about in this budget. It's a very good one and we'll just be tinkering a little bit." I hope you will remind Congressman Brown of that statement. I wish it had happened in my day.

Let me say that since you're all agreeing that except for trying to increase perhaps the apportionment in the engineering research centers and a few things like that, that this is going to be a comfortable year for you, at least in your own sessions, I would like to give you a challenge to do some other kind of work. The very first question you asked me about was the overall budget, and obviously everybody has responded that it is a very rewarding thing to see the National Science Foundation picked out as one of the agencies that got a substantial increase, an increase in fact over expected inflation.

That really represents two things, I think. It represents the recognition that science and its application, applied science, is very important to the Nation. That recognition has been growing steadily since the very beginning of the NSF, and that's very good.

The other thing I think it recognizes is that the National Science Foundation as an agency is capable of doing this job quite well. I believe that very strongly. But I do think, since your oversight is on more than just budgets, you ought to look occasionally to the question, are there any things you can do to help the National Science Foundation do its job better. And perhaps if you have extra time this year, you ought to spend some of it on that.

I could give you suggestions. I will make one at this time for you to examine. Back in my time, one of the things I noted was that the leaders, the Assistant Directors who were operational commanders of the various parts of the National Science Foundation, those slots were vacant quite often for a while, and we would fill them and so on. Now, it's bad to have the directorship of an operational part of an agency vacant and have it shifting, popping in and out kind of thing. That problem has grown worse.

I think it may stem from many things. But one of the things it stems from clearly is the fact that these jobs, the Assistant Directors, are Presidential appointees, and it takes quite a bit of time to get Presidential appointees made, especially at the lower levels of the Presidential appointee list.

Now, those Presidential appointees are really selected because they're policy makers, mainly. That's the hold that the administrations like to have on those leaders, and it's the hold that the Congress would like to have on the policy makers. The NSF has plenty of policy makers, 24 members of the National Science Board, Presidentially appointed and approved by Congress. It has the Director and the Deputy Director and the four assistants.

I think you ought to analyze whether you shouldn't make the operational jobs non-Presidential appointees. It might make for a lot better operation, and you will discover if you look at the data that that gap that I mentioned that I saw when I was there 10 years ago has in fact grown, at least in some of the areas. It's a very serious problem.

I don't think you're going to lose your policy grip on the NSF by a reduction. It may be that you will want to use in addition to the Director and the Deputy Director one of those Presidental appointments for another policy level job, which I will come to later. That's the first point.

The second point that I would like to make, since you asked me to talk about the division amongst and between the various parts of the National Science Foundation, there are two principal areas that you have been talking about all afternoon, you and your witnesses; and that is, between the support of basic research and the applied research, and particularly engineering. Now, applied research is done, is supported by the NSF, in more than just the engineering directorate, and you should recognize that. And it's the applied research in physics which is very naturally supported, I think, in the area of the math and physical sciences and so on.

But the problem is—it's very important to me to recognize; maybe you won't agree with me—I think the fact that now we're picking up on the support of the applied research and engineering in the National Science Foundation is an additive thing that has been conceived for the National Science Foundation in its 35 years of existence, and not something that's a balancing between two different kinds of things.

You know, there are lots of ways of saying that science in its pure form and science in its applied form are both very important. I could say it in my own words. Louis Pasteur a long time ago said simply, "There are science and the applications of science bound together as the fruit to the tree which bear it." I think that this is an important thing for you to recognize.

I think it would be a great disservice to science and technology in the United States if suddenly we said, "The National Science Foundation is shifting from the basic to the applied," I think the pressures on you and the other people in this country are going to be very heavy on the applied side, the engineering side, and I am very much behind it. I spent most of my career on that side of the business. And the kinds of things represented by the engineering research centers, those are great. They've been worked over for almost 10 years in shaping them into something worthwhile, and we're getting them up to where I think the pressure will grow to build those. And I would like to see them grow, but I would hate to see them grow at the expense of the basic research side. I think this is an important general consideration in the balancing of that budget.

The third thing that I will pick out of my testimony—and I appreciate your offer to put it into the record—the third thing I would like to talk to is international science. Today we talk about international science and technology problems, and they, too, are interleaved. But there are some differences.

You know, there is hardly a scientist in the world who would not describe his field as having an international base. As some great scientist in the past said, "There is no more a national science than there is a national addition table." Science is an international fact.

So, too, are engineering and technology, but the important thing is that there is a different set of constraints on that. The constraints there stem in technology from the pressures that industries have to maintain their secrets through patents and their industrial secrets and so on to maintain their company competitiveness. It stems also from the importance of national defense. You have to treat these differently. The National Science Foundation can play a role in both. Their biggest role has been on the pure science side, in the past. This country isn't doing a very good job—and I think several people mentioned it; I know that Dr. Hamburg mentioned it—in the totality of its international relations in science and technology. The State Department is not strong enough in talent, and hasn't been for a long time, to handle its full responsibilities. It can overlook things and say, "Sure, that's a possible thing to one agency of government to the other." It can say, "You're not breaking any international laws or treaties here. That's fine."

But what we need really is a better grasp of the totality of the opportunities in exchanging science and technology abroad. There's the quid pro quo opportunity. There's lots not only of good science, there's lots of good technology abroad, and we ought to be more efficient in arranging that.

So to strengthen ourselves, it's important to strengthen our international exchange. It's important to get friends and maintain friendships. And I think it's important, and it was mentioned again by some of the previous witnesses, to do our humane bit with our extra talent in this field to the very poor countries.

The National Science Foundation does some of this, but only part. It has some things that it does that are just internal to science. When a scientist's research program needs him to work abroad with a fine piece of equipment or with some foreign scientific talent, it can arrange that. And if a field of science needs a large international organization like the deep-sea drilling project, NSF can arrange that for the scientists in that field. Very important. These are internal to science itself.

There is one external force that NSF bows to, and that is international political pressure. Whenever an administration either pressed by Congress or by its own desires sets up a relationship with a foreign country that it wants to build a friendship or to get something out of or to get an alliance with, one of the first agreements that is made is a science exchange agreement. And we have a lot of bilaterals. And making a bilateral science agreement is a very important thing with the United States, a very important thing for a foreign country. Breaking it is equally important to the other side. But what we do is let the support of that drift down from that initial political impulse. Its importance stays up there, but the political focus—you know, politics shifts around very fast—the political focus drifts and the support drops. That's a bad effect, and it is happening and you should examine this in the NSF budget.

I would like to see the NSF use its capabilities, its connection with the science world, as Dr. Hamburg said, its connection to the world of science abroad, its connection to the science world here, use its capability more and be supported in it to establish a better data base, to have a better analytical capability, an evaluative capability, to find out where the gaps are, to make suggestions throughout the country.

And I think that this role should be magnified. It can be. I believe that the National Science Foundation could step up. They could help the State Department a lot more. They could help the White House a lot more with the resources. I think they're the best agency to do it.

By that I do not mean that they should get control of all of the other powerful agencies in their overseas activities. But they should be aware of them, evaluate them, keep the data on them and so on. I think we have a wonderful opportunity.

Well, I made some other points in my testimony, but I will stick to those.

[The prepared statement of Dr. Stever follows:]

Statement by Dr. H. Guyford Stever
to
The Science, Research and Technology Subcommittee
of
The Committee on Science and Technology
U. S. House of Representatives
Washington, D. C.
February 20, 1985

Mr. Chairman and Members of the Subcommittee:

It is a privilege to testify to you at your authorization hearings on the FY 86 budget proposal for the National Science Foundation (NSF).

You have asked me to address the adequacy of the overall budget proposal, the long-range implications of the budget, and the appropriateness of the distribution of funds to meet NSF's role in support of research priorities for science and engineering. Also, since I serve as Chairman of the Directors's Task Force on NSF International Strategy and Programs, you have asked me to express my views of the role of NSF in representing U.S. science interests in the international arena, how NSF's activities in international science are perceived by the research community and cooperative partners in international science, and the impact of the United States' withdrawal from the International Institute for Applied Systems Analysis (IIASA) and the United Nations Educational, Scientific, and Cultural Organization (UNESCO) on NSF's future role in international science.

Let me begin by addressing the long-range implications of the FY 86 budget proposal for the NSF, and begin by looking back to the establishment of the NSF three and a half decades ago. There was a strong belief at that time, shared by leaders of government and of science, that our country needed to strengthen basic science, especially in our universities, in order to round out our total strength in the broad spectrum of science and technology needed by our country, a spectrum of activity ranging from basic research and applied research in all the sciences, to development, to test, to design, to use. In the aftermath of World War II with its spectacular successes of applying science and as the country returned its industry to rebuilding our normal economy, there was plenty of activity in the applied end of science Our leaders wanted to balance the effort by the support of basic science. The establishment of the NSF was one of the most important steps they took to achieve this end. I believe time has proven the great wisdom of our government and science leaders of that time and we should often remind ourselves of it to assure the continued support of the basic sciences. If we do continue to support the basic sciences as we have in the past 35 years, we will continue to reap great benefits for a long time to come.

Let me now turn to the question of the adequacy of the FY 86 proposed budget for the NSF. In noting that the NSF is one of the few agencies selected for an increase over last years budget, in fact over expected inflation, an increase of seven percent, I, for one scientist, would like to express gratitude for the recognition of both the importance of the NSF mission and the capability of the NSF to perform that mission. Such an overall budget proposal will probably bring less discussion than the appropriateness of the funds within NSF so I would like to turn to that issue.

Our basic science is strong and if we continue its support it will remain so. In examining the strength of the support for basic science research, we must remember that most of the sciences are in very productive and promising state at present. You will hear much specific evidence of that. Furthermore, many of the sciences need to augment the tradition of the "small" science research approach with some "big" science activities characterized by greater organization, larger groupings of scientists working together, and/or bigger, more complex, more expensive research apparatus. To continue to be a world leader in many fields of science will require a growth in expense, greater than normal inflation, and this must be recognized. In the light of the tightness of this budget year, increases of from 6% to 8% for the NSF directorates which carry the brunt of the load of support for the basic sciences seem to be very good and should be quite acceptablefor now. However, in the longer run the above mentioned forces on adequate funding for basic science research must be handled if we are to remain in the forefront.

The proposed budget for the Engineering Directorate is up 13% this year, and, within that directorate, the largest increase is in the Cross-Disciplinary Research and the Design, Manufacturing, and Computer Engineering line items with increases of 58% and 19% respectively. I believe this is a good response to the priority pressures on NSF this year. For more than a decade now there has been an increasing recognition in the industrial, governmental and academic segments of our country that, though our basic science has been strong, there has been a lag in our getting the basic science ideas incorporated into industry, agriculture and medicine, the three activities in which most science is applied. Within the NSF there has been a continual examination of the part that NSF could play in helping the engineering complex perform better. This sharp increase in the budget of the Engineering Directorate is a principal response to this need, along with a corresponding increase in the attention paid to the support of applied science by the directorates which have their principal role in the support of basic research.

Even though there is a sharp increase for the support of the Engineering Research Centers, I believe that we will find these to be particularly effective in the training of engineers to make substantial contributions to the competitiveness of U.S. industry. And there are so many good proposals in this area that the Congress must expect this program to grow substantially with the years.

I believe that both of the roles, support of basic research and support of applied research and engineering, can be well done by the NSF. However, both roles are important in their own right and it behooves us to think of them together as net added responsibility for NSF rather than as activities which can be played off one against the other.

On the budget for the Science and Engineering Education Directorate, I am not sure that I can add much to the discussion that will be helpful except to say that I have rarely talked with an interested or informed person who did not consider the subject of science and engineering education important for the scientists and engineers themselves, for those in government or industry who made decisions on matters heavily impacted by science and engineering, or for the electorate in general who often express themselves on matters in which science and engineering play an important part. I should add that the NSF has always found itelf in between those who argue, not about the importance of the subject, but about the role that the federal government should play. My experience is that this argument always comes out a draw, for the amount of support for the area has stayed at about the same relatively low level from the time I became close to it two decades ago. I believe that: the Fellowship programs are important; there is a clear and present danger in our failure to make attractive and to train for careers in mathematics and science in the secondary schools; it is important to introduce the talented students in math and science to advanced work in the fields including exposure to real experience in laboratories or industries; schools need help in getting the required laboratory and computer facilities to do their work properly. I understand that the NSF is trying to construct worthwhile programs in these areas.

May I turn to NSF's role in international science. It is difficult to find a scientist who does not view his field of science as international in scope: scientists from all of the developed countries, most of the developing countries, and some of the less developed countries, all contribute to the body of ideas and data on which all scientists depend; there is a lively exchange of these ideas and data through books, journals, conferences, laboratory visits, working together in joint research programs, or using one another's unique apparati or facilities;

and there is a substantial amount of exchanging of students in science amongst the universities of the world. The world of science is very closely coupled. Most Engineers also look on international engineering in similar ways, though there are more obstacles to their exchange of technology than in the exchange of scienctific knowledge. These obstacles stem from the patenting or holding technology confidential for industrial competitiveness purposes or for protecting defense information. Even so, there is a great exchange in the engineering field as well.

In the light of the above, NSF finds itself supporting many international science activities, some of them with motivations entirely originating from within the science enterprise itself. Many of the research proposals submitted to the NSF for the advancement of a particular science naturally have some international aspect. In keeping with its tradition and practice of peer review, these international activities are judged and supported on the basis of their contribution to advancing science and not separated from the rest of the activities. There are a few constraints which are applied, but the research granting directorates handle this kind of international activity very well. The budget for these activities are naturally included in the budget of each research directorate and it appears that the activity is healthy and well handled.

A somewhat different class of international activity also originates naturally within the sciences. This class is characterized by a requirement for: a large facility used by scientists of other nations as well as our own; an ad hoc or permanent international group of scientists to oversee, secure and analyse scientific data; or the establishment of a major facility or site of ours on foreign soil. The sciences handled in the Astronomical, Atmospheric, Earth and Ocean Sciences Directorate are very much of this type, yet some of the other research directorates also participate in this class of international science. As in the first type of international activity, these projects must be judged and supported in the normal way, but because of their scope, they must be handled with a more powerful organizational arrangement. NSF does a good job with this class of activity.

A third class of international activity supported by NSF is originated not by the science community itself, though scientists conduct the programs, but rather by the U.S. Government itself. The Bilateral Science Programs, administered by the International Programs Division of the Scientific, Technological, and International Affairs Directorate, of which there are several dozen, result from an international agreement between the United States and another country. They are almost always motivated for inter national political reasons. Some are long standing and have remained quite healthy; others are somewhat neglected as a result of changing international needs or foci; but the cut-off of any is somewhat traumatic. The NSF does a good job with these programs, but it has had a difficult job in securing funding for them over the years as political interests wax and wane. The International Programs Division also funds many other activities. For example, the international exchange programs of the National Academies are funded by this division, as is the support for ICSU, the International Committee of Scientific Unions. Many other institutions with legitimate and worthwhile programs deserve support. Before the cut-off, support for IIASA came from this division of NSF. You will note a proposed cut in the budget for this division for this year, which you should examine closely, especially if NSF is expected to pick up the support for certain international activities of interest to the U.S. which were formally supported by UNESCO, and/or if IIASA is to be revitalized.

The international science activities of the nation are in serious need of overhauling at this time for several reasons, and I believe that the NSF can help in that overhauling and continue to play a much larger role in the future. The reasons for change are many: there is a strong movement for aligning new international relationships and realigning old ones, always present but more active now; science and technology have a much better recognized role in both international trade and defense than in the past; basic science which is primarily supported by governments is shared widely in the world, and as it grows more costly, there is a desire for sharing expenses as well; the nations of the world share many problems such as environment, supply of natural resources, health, weather and climate, aid to the poor nations where science and technology play major or supporting roles.

There are several government units which must and do play important roles in international science affairs; the Office of Science and Technology Policy with a policy role; the the Oceans, Energy and Science Office of the State Department in a policy interpretation and facilitating role; the Departments of Defense, Energy, Agriculture and others, as well as several mission agencies like NASA, in operating programs in their areas of responsibilities. There is not much in the way of holding these activities together, however, let alone putting together a well coordinated program for the country. The OSTP has only limited time and staff to do its job; the State Department seems to be even more limited in its staff coverage to handle its overall coordinating role. NSF could help both of these agencies, given the resources, and could probably do the information gathering and analyses better because of its numerous science contacts abroad and in this country. It could act as a central gathering place for those in operational agencies with foreign science responsiities. Especially it could serve as a contact for foreigners coming to this country on scientific missions who needed help in finding their way either in the governmental or private science communities. In all of this central activity, the NSF would necessarily have to be extremely careful to make sure that it does not convey the idea that it controls the activities of other agencies, a role beyond its capabilities.

To assume this wider role in international science, the Director would need a policy level deputy to assume the coordination of the internal NSF activities, and to act as an NSF foreign secretary for science to accomplish the outside international activies. I believe that such a broadened role for NSF would help this country immeasureably as it faces a fast growing world of international science

Thank you, Mr Chairman and members of the Subcommittee.

Mr. WALGREN. Well, thank you very much, Dr. Stever. Those are nicely specific, and we would be very interested in pursuing them and seeing if we can't develop them for you.

Let me turn then to Mr. Sloane, who I understand has a 5 o'clock plane. We will make sure that you meet that commitment. I apologize that this has gone on so long. We didn't really expect it. So you have my apologies, and we won't violate that airplane.

Mr. SLOANE. There is always another airplane, but just one chance to do this.

[A biographical sketch of Mr. Sloane follows:]

JOHN H. SLOANE
Vice President - Engineering

John H. Sloane, vice president engineering for Aluminum Company of America, was born July 17, 1933 in Maryville, Tennessee.

He received a B.S. degree in electrical engineering from Washington State University in 1956, and an M.S., also in electrical engineering, in 1964 from Oregon State University. He completed the Harvard Advanced Management Program (AMP) in 1981.

Mr. Sloane worked for Alcoa as an electrician's helper at Vancouver Operations for the summer of 1955. He began full time employment in 1956 as staff electrical engineer in Vancouver. He held various positions there, in Lafayette, Ind., and Cleveland, Ohio. In 1964, he was promoted to supervisor of electrical engineering, Cleveland, in 1966, senior electrical engineer, divisional electrical engineering, Davenport, and in 1967, senior electrical engineer-manager process control, Pittsburgh. Three years later, he was named assistant engineering manager, and subsequently engineering manager, Davenport. In 1975, Mr. Sloane returned to Pittsburgh as chief electrical engineer. He was named general manager-manufacturing flat rolled products in 1978 and became general manager-engineering in May, 1981. He was elected to his present position in July, 1982.

Mr. Sloane is a member of the Institute of Electrical and Electronic Engineers, the National Society of Professional Engineers and the industry advisory committee of the American Association of Engineering Societies. He also is a member of the Engineers' Society of Western Pennsylvania, involved with the Boy Scouts of America, and a board member of the Greater Pittsburgh Guild for the Blind.

STATEMENT OF JOHN H. SLOANE, P.E., VICE PRESIDENT FOR ENGINEERING, ALUMINUM CO. OF AMERICA

Mr. SLOANE. Thank you, Mr. Chairman.

I am especially pleased to be asked to testify before this group to talk about the National Science Foundation. And one of the blessings of coming after five distinguished panelists like this is most of what you wanted to say has already been said. [Laughter.]

But let me come at it from a slightly different perspective that I think would be of interest to this subcommittee. And I come with a background of having practiced engineering in basic industry for 25 years, a member of the National Society of Professional Engineers and Lord knows how many other technical societies, so it's been my life for these past 25 years. And I believe in the things that the Foundation is doing, I really do.

I am for the advancement of science and the funding of universities and all that good stuff. But what I would like to talk to you about as a member of basic industry is what I call the harnessing of brainpower. And through the time that I have been with Alcoa I have been increasingly impressed as time goes on with the critical importance of young engineering and technical talent to the survival of basic industry in our country.

Now, we're not big in terms of total numbers of engineers hired. We hire 100 to 200 engineers a year, and most of those come directly from colleges and universities. And I am here to tell you that without that assured pool of highly qualified engineering manpower, we couldn't continually bring fresh ideas and innovation to our business. We would be severely limited.

In a very real way—it sounds a little corny—but those young engineers and that fresh new technical talent, with the great engineering education that we're capable of delivering if we can figure out how, are the seed corn of our technological progress, and indeed they're our hope for the future.

Now, the thing that I would like to have the subcommittee understand is that the National Science Foundation plays a unique role among Federal agencies. They foster university-based research and talent, and by doing so, they help to lay the foundation of the long-term competitiveness of American industry in today's world.

I am particularly encouraged by that present emphasis. I think the strengthening of the engineering directorate is very appropriate. And I think that the addition of an engineering mission to the Foundation's charter is a must.

Now let's try to contrast, as we've already done, between why that's important. The university-based research and talent sponsorship by the NSF is really generating talent and research for the sake of generating talent and for the sake of knowing how to do research, while industrial research is more focused at product or process.

Again I would like to request your help in shepherding the engineering mission statement to the NSF charter through the Congress, and I am pleased to hear from our conversations earlier that that's going well.

Now, let's also talk about engineering. And Dr. Stever referred to that. There is a distinct difference between pure scientific research and applied research. And I think Dr. Stever said that very eloquently. And it's the purpose of engineering to bridge the gap between the knowledge that's generated out of science and the fulfillment of our national needs. While the responsibility for commercially viable products and services clearly lies with the private sector, it's important to establish a base of fundamental engineering research technique and talent that only the NSF can do.

We talked earlier about some of the funding, and I will not repeat those numbers. However, I will express my concern over the importance of high-level technical instruction in the engineering schools in this country and the fact that nearly 2,000 engineering faculty positions have been vacant for the last 6 months without even one qualified U.S. citizen applying for those jobs.

We talked about that earlier, and I don't want to reemphasize it. But I do want to point out that without the high level—without the high level—technical ability of those engineering professors teaching the bright young people of today—and I am an optimist about that, there are lots of ponies coming out of those high schools, in addition to some of the problems, but there are. They are bright kids, and they need to have the quality of instruction that will unlock and harness the brainpower that I talked about a minute ago.

The proposed $20 million increase for the engineering directorate I believe is clearly warranted. I look at that as an additional $20 million investment in the future of our Nation. I can't say it too strongly. The ability of industry in the United States to compete on a worldwide basis depends directly upon our ability to harness our technology and compete technologically in the world.

And, yes, I understand that this is not the time, as was mentioned earlier, about requesting increased budgets. But from my perspective, our company increased our R&D budget 20 percent this last year. And those of you that know about the aluminum business know that was pretty imaginative. But the reason for that is our belief that technical superiority is critical to our survival in the industrial world.

Emerging technologies have been mentioned. And there is a serious lack of fundamental research for the private sector to draw upon. An analogy to that, for example, would be those things that are generic that require engineering research. One of those that has been mentioned is manufacturing systems. Now, we would be inclined, for example, to focus our research on things that have to do with the aluminum industry and not on our own book and for our own account put money into manufacturing software. But it's critical to our survival, and that seedcorn needs to come from somewhere, and I am suggesting that the university-based kind of research is a place to do that.

I think Dr. Nam Suh has done a brilliant job in sorting out the engineering directorate and focusing the new organization on those engineering things that really need attention at this point in time.

One more point, and that is that I have mentioned also about the individual investigator grants of the NSF for engineering research as well as for a broad spectrum of research, and I think those are super programs. They're focused, and they rifle in at one thing.

But one thing that we've noticed recently in trying to move an industry such as ours into a new technological world is the incredible complexity of getting that done, and the fact that metallurgists and electrical engineers and mechanicals and civils and chemicals don't work in isolation anymore; they have to work in teams. And those are interdisciplinary teams to define the whole of the manufacturing process or the whole of the production process. And that's precisely where your cross-disciplinary engineering research centers are aimed, and they do apply the opportunities to get some of that done.

Now, again what I am looking for is harnessing brainpower that I can bring into my business and make us competitive in the world. And if, through the funded research in universities these bright young people are beginning to understand how to perform in an interdisciplinary world, then that gives me the raw material that I need to get the technical job done that we have to do.

Now, there are all kinds of ways to do that, and we've had some discussion about that. And I am sure, Mr. Chairman, you're aware of the Ben Franklin partnership in Pennsylvania. And that's a partnership between academic, government, and private sector resources to stimulate the development activity of advanced technologies.

Now, there are four of those. Let me give you an example of what can happen. There are four of those advanced technology centers, and they have leveraged $55.6 million in matching funds as of August 1984. As an example, Alcoa teamed up with the University of Pittsburgh and a dozen other metal companies in a project that's known as Basic Metals Processing Research Institute. It sounds like a government agency, doesn't it? [Laughter.]

Mr. **Sloane**. The total budget was $529,000, not a huge project. Ben Franklin put in 175, and all the rest was leveraged out of the participating companies. My point of that being that I believe that industries such as mine are willing to participate but cannot carry the whole burden alone and would participate with matching funds or whatever.

Well, those are some ideas. And again I took you at your word because all of this has been said before. But in conclusion, I would like to say this, that because I am absolutely convinced that technological achievement is critical to the survival of American industry—that's my industry, and I will make that as a more generic remark over time—I hope that this subcommittee will continue to support the NSF efforts to strengthen American science and engineering.

The progress that's been made in the last year is very encouraging. I don't want to say I don't think enough has been done. A lot is being done. But we've got a big job to do. And that further substantiates our strong belief that a strong partnership between science and engineering within the National Science Foundation, as Dr. Stever says, is the right and proper course of action.

I look forward to working with you and doing whatever I can to help that effort. Thank you.

[The prepared statement of Mr. Sloane follows:]

TESTIMONY OF
JOHN H. SLOANE, P.E.
VICE PRESIDENT FOR ENGINEERING
ALUMINUM COMPANY OF AMERICA
BEFORE THE
SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
ON THE
FY' 86 NATIONAL SCIENCE FOUNDATION AUTHORIZATION
U.S. HOUSE OF REPRESENTATIVES
FEBRUARY 20, 1985

Chairman Walgren and Members of the Subcommittee:

I am pleased to respond to your invitation to testify on the FY' 86 budget authorization for the National Science Foundation. I am John H. Sloane, P.E., Vice President for Engineering of the Aluminum Company of America (ALCOA), and a member of the National Society of Professional Engineers (NSPE).

NSPE is a non-technical professional society, representing over 80,000 engineer members nationwide. The members are organized into 54 state societies and 500 local chapters, and work in industry, education, private practice, construction and government.

I appreciate this opportunity to share my views on the National Science Foundation with you. Throughout my years with ALCOA, I have been continually reminded of the critical importance of young engineering talent. ALCOA hires approximately 100-200 recent engineering graduates each year, depending on the economic cycle in our business, most of whom come directly out of universities and colleges. Without an assured pool of highly qualified engineering manpower, our ability to continually bring new ideas and innovations to our corporate endeavors would be severly limited. These young engineers are our seed-corn for technological progress; our hope for the future.

The National Science Foundation plays a unique role among Federal agencies. By fostering both university-based research and talent, NSF helps lay the foundation for America's long-term technological competitiveness in today's industrial world. I am particularly encouraged by the current emphasis, which better establishes this relationship by strengthening the NSF Engineering Directorate and adding an engineering mission to the Foundation's Charter.

Before commenting on the budget, I would like to express my strong belief that legislation to add an engineering mission statement to the NSF Charter is extremely important. I hope this Subcommittee will be able to again provide the leadership necessary to pass the bill through Congress, and am pleased to see that this year, the President has requested the change. While an improved structure and mission statement will clearly not solve the engineering community's need for research and education support, it will insure that engineering programs are conducted in the proper environment. Without a supportive mission and structure, the future strength of the Foundation's engineering programs is uncertain and subject to the whims of the time. While the current Administration's firm support is appreciated and encouraging, it is insufficient. As we all know, roller-coaster funding thwarts technological process like nothing else. The current troubles of the Science and Engineering Education Directorate are testimony to this premise. I hope we will be able to pass an engineering amendment to the Organic Act into law this year, and again offer you our full support in developing a workable plan. I am increasingly convinced that progress in this advanced technological world requires time and patience.

Engineering bridges the gap between scientific knowledge and the fulfillment of national needs. While the responsibility for developing commercially viable products and services clearly lies with the private sector, the importance of establishing a solid base of fundamental engineering research and talent cannot be overlooked.

NSF's proposed $170 million engineering program provides a desperately needed source of support. With engineering enrollments having skyrocketed 118% over the last decade, the parallel growth in faculty has reached just over 15%. There are now nearly 2,000 engineering faculty positions going unfilled. Many of these slots have been vacant for over three months without attracting even one application from a qualified U.S. citizen. Yet, NSF's current FY'85 engineering budget is estimated to have the capability of producing only ten Ph.D's per state per year. Coupled with an instructional equipment deficiency of approximately $2 billion, not including computers, the needs of our nation's engineering schools are overwhelming. Cooperative efforts between government, industry and the academe are the only way these problems can be effectively met.

The proposed $20 million increase for NSF's Engineering Directorate is clearly warranted. I recognize and applaud the need for budget austerity, however, I believe that spending $170 million in NSF's engineering programs is a necessary investment in the future of our nation. Even with the increase, engineering makes up just 14% of the total NSF budget. An analogy would be that my company, in the face of intense international competition, is increasing R&D expenditures in 1985 by more than 20%. This is evidence of our belief that technological superiority is critical to our survival in the industrial world.

Particularly in emerging technologies, there is a serious lack of fundamental engineering research for the private sector to draw upon. In these same areas, there are few educational programs which can train engineering students and channel them into these growth technologies. Dr. Nam Suh, NSF's new Assistant Director for Engineering, is to be commended for recognizing these needs and addressing them through a reorganization of the engineering directorate. The new structure will foster research in critical areas such as manufacturing systems, design theory, and process engineering, which previously received little attention.

The new structure also better highlights the characteristics and needs of the engineering field. By differentiating between those areas that have a well-established base of scientific knowledge and those that do not, the need for both empirical and experimental knowledge is more obvious. The new Science Base Development in Design, Manufacturing, and Computer Engineering program and the Fundamental Research in Emerging and Critical Engineering Systems program offer great potential and should be of the highest priority.

Further, the broad spectrum of engineering research needs cannot be adequately addressed through individual investigator grants alone. Much of the research demands an interdisciplinary, team approach. The Cross-disciplinary Engineering Research Center program is essential to provide opportunities for this research. In the first year of this program, I understand that 142 proposals were submitted, which means that nearly one out of every two accredited engineering schools in America is seeking funding from the ERC program. Clearly, NSF does not and should not have the ability to fund every proposal received. While I strongly support the Foundation's strategy to first establish a small number of centers of excellence and then expand, $25 million is the minimal funding level that could even begin to meet the demand. I urge the Subcommittee to allow the ERC program to continue growing.

I would also like to comment briefly on the viability of the Center approach to developing regional excellence in a given technical area. I strongly believe that NSF is moving in a proper and effective direction with both the Engineering Research Centers and the STIA centers, which by the way, I am pleased to see more closely linked. My strong support for the center approach is based, in part, on our experiences in Pennsylvania.

We have a state-wide initiative known as the Ben Franklin Partnership Programs. Established in 1982, this program has forged a working partnership between academic, government and private sector resources to help stimulate the development and application of advanced technologies. Through four regional university-based Advanced Technology Centers, the Ben Franklin program leveraged approximately $55.6 million in matching funds as of August, 1984. As part of this program, ALCOA teamed up with the University of Pittsburgh and over a dozen other metal companies in a project known as the Basic Metals Processing Research Institute. The total project budget is approximately $519,000, with the Ben Franklin Program allocating $175,000. Through the R&D and technology transfer activities of the project, 191 jobs are projected to be created and another 381 saved over four years. These centers not only contribute critical scientific and engineering research and training opportunities to Pennsylvania, but spur economic development as well. The same should be true of NSF's centers.

In conclusion, I hope the Subcommittee will continue to support the National Science Foundation's efforts to strengthen American science and engineering. The progress that has been made in just the last year is tremendously encouraging, and further substantiates our belief that a strong partnership between science and engineering within the National Science Foundation is the proper course of action.

I look forward to working with you as your work proceeds, and again thank you for the opportunity to testify.

Mr. WALGREN. Thank you very much, Mr. Sloane. That's well said, and particularly from the direct private sector experience.

Let me ask, Mr. Boehlert, if you would like to explore anything with Mr. Sloane, and then we probably should let him go.

Mr. BOEHLERT. Mr. Sloane, thank you for your statement.

Mr. SLOANE. Yes.

Mr. BOEHLERT. ALCOA hires 100 to 200 engineers a year, on average?

Mr. SLOANE. Yes.

Mr. BOEHLERT. Undergraduate, graduate, what's the percentages?

Mr. SLOANE. The mix on that is mostly undergraduate except at our research facilities, and that is highly weighted toward M.S.-Ph.D. types.

Mr. BOEHLERT. Are you having a difficult time getting the M.S.-Ph.D. types?

Mr. SLOANE. We are. We are. And very much of that is for the reasons that you mentioned earlier. The starting salaries for bachelor's degrees are very high, and, you know, it's a complicated kind of thing. But please try to understand, if you look at the undergraduates in engineering schools today, a high percentage of those are on some kind of financial aid that has to be paid back. And I have seen kids at engineering school on financial aid, and they don't have many bucks in their pocket. And when you roll 25K out on the table, they just about jump through the roof. Now, that's one practical part.

The second practical part are the students that perhaps the money is not all that important, but will look at an additional 4 years and say, "If I do it another 4 years, unless I really am just burning up for a technical education, it's not going to do me economically all that good." And, yes; it is a problem. It's a problem for us more in the basic engineering—mechanical, electrical, chemical, civil—than it is in the metallurgy and the things that people associate more directly with the high-technology end of the aluminum business.

Mr. Boehlert. How do we keep people in engineering education when companies like Alcoa are luring them away systematically with the promise of bigger and better paychecks?

Mr. Sloane. Well, you do a good job of training them. No, I seriously think the answer to that is things like your university-based research centers; for example, where that money can go to support a research program. And I really mean it. If something's being accomplished, I think the private sector will come up with matching funds and that sort of thing, and then that body of money can go to support graduate assistantships and/or augment professor salaries. And that's being done in several places.

The manufacturing thing at places like Rennselaer and Purdue and Carnegie-Mellon and other places are really beginning to attract consulting things to supplement faculty salaries. And Dr. Stever is the specialist on faculty salaries, and not me.

But I think all of those possibilities exist to try to elevate the level of faculty salaries and to support graduate students.

Mr. Boehlert. Does industry—and this is the last question, I know you have to dash, but I just thought of something as you were talking—does industry ever do what we do in the Federal Government, for example, to provide physicians for medically underserved areas; that is, take a promising graduate student and finance—undergraduate student upon the completion of his baccalaureate program—finance the graduate program in return for a commitment to come to Alcoa, for example?

Mr. Sloane. Not in that sense, no, we do not. We do, however, have graduate engineers, for example, who are on our payroll and we have identified a need for a new course and would send him to that course as his full-time assignment for a year, but without a commitment to come back.

Mr. Boehlert. Have you ever looked at it? Is it intriguing at all, or is it a harebrained scheme?

Mr. Sloane. To pick up an undergraduate student and pay for his graduate work?

Mr. Boehlert. Exactly. In return for a commitment through——

Mr. Sloane. No; we have not.

Mr. Boehler [continuing]. A contractual arrangement.

Mr. Sloane. We have not. It is a rather common practice, however——

Mr. Boehlert. Oh.

Mr. Sloane [continuing]. In industry. Yes, it is.

Mr. Boehlert. All right. Thank you.

No further questions.

Mr. Sloane. You're quite welcome.

Mr. Walgren. Well, let me on behalf of the committee say thank you.

Mr. Sloane. You're welcome.

Mr. Walgren. We appreciate your being a resource, and we look forward to talking with you about this in the future.

Mr. Sloane. Glad to be here. Whatever I can do to help I will.

Mr. Walgren. Thank you very much, Mr. Sloane.

Mr. Sloane. Thank you.

Mr. Walgren. Well, let us turn to Dr. Stever and just explore a little bit.

You indicate, Dr. Stever, in your general statement that you've stressed the importance of continuing support for the basic sciences and go back over the 35 years and say that if we don't continue that we're going to be in real trouble. How do you view the last 15 years in terms of continuing the support for basic science? It's my understanding that we have at least come into, after inflation, largely because of the degree of inflation, a relatively flat funding period. And do you view that as doing enough, or should we really be thinking of substantially increasing the NSF budget, in your view, to continue the support of basic science as we have in the past?

Dr. STEVER. Mr. Chairman, you know, with the NSF budget up as it is in a very tight year, I really feel inclined just to say thank you.

Mr. WALGREN. Yes.

Dr. STEVER. But let me say that both of these fields, the basic and the applied—applied running into engineering—I do believe they go well together. I know they're both needed very badly by the country, and I think the recognition is growing, and I think we ought to begin to readjust over the years to be able to lift support for both.

Mr. WALGREN. Yes.

Dr. STEVER. I think the support of one without the other, will get us in trouble again. You support the applied and you solve shorter range, and then you're short later.

Furthermore, the basic feeds so quickly into the applied and the engineering, I think they're really needed together. And what my message really was is that both of these need support. I approve of the larger budget this year for the engineering because that's later in the NSF history. It's growing, and it should grow, and I am very strongly for it.

But I say, let's not separate these two. Bring them along powerfully together.

Mr. WALGREN. Yes. And to do that, what I hear you saying is that you're going to have to add funds to do that because——

Dr. STEVER. Yes.

Mr. WALGREN [continuing]. You're adding an additional function that hasn't been there in the past, and if that's to be the case, then you must add new money unless you are to undercut the——

Dr. STEVER. I think so, yes. I really do think that. You know, it's interesting, being a registered Republican, I am sympathetic with the attempts to make sure that Federal responsibilities are clearly defined and local ones are clearly defined and private sector versus government and all of that. But in the areas that we're talking about—that is, the basic research and the early stages of the applied research and the kind of thing that Mr. Sloane talked about, these engineering research centers—they're not the kinds of things that industry, the private sector, can step up to alone. I do think that they are Federal things.

So that whole spectrum, I don't think the Federal Government should be in the business, the next part of the spectrum, the development process, development of product and so on. But there is a part that is very properly Federal responsibility, and I think you've now got NSF covering a more complete range of that responsibility. And I think you do have to step up over the years to do it.

Now, I don't think you can go in one massive step. NSF has got to adjust to it.

Mr. WALGREN. Yes.

Dr. STEVER. I think we have to adjust to those engineering centers, but next year I think you'll be asked for a lot more.

Mr. WALGREN. Yes. And you foresee, or someone foresaw, very specific pressures coming out of the range of the spectrum, as you've urged, toward the applied, that that's going to be a more focused constituency and a stronger voice at that point which may override some of the less demanding areas?

Dr. STEVER. I have heard what Mr. Sloane said from more and more leaders of industry in this country--support NSF across that spectrum.

Mr. WALGREN. Yes.

Dr. STEVER. And I think that's a very rewarding thing for those of us in the field and for you people who spend your lives also deeply in this.

Mr. WALGREN. Well, let me ask you a more historical question if I might. That is, before we took on the engineering emphasis last year, if you were to look at the NSF budget, let's say, in 1980, even before the Reagan administration, how would you view the NSF coming out of the 1970's compared to its strength when it went into, let's say, the late 1960's?

What I am trying to figure out is, in your statement you, more than most, have a historical perspective on this, and I wonder how we're doing in the long run of these decades.

Dr. STEVER. Well, obviously, there was the thrust from the whole country along right after Sputnik—and it lasted about a little over 10 years—a very powerful thrust to increase all of this, including science education, which we haven't had time to talk about at all. And that grew, and then there was very clearly a leveling off of the budget. I don't think we got weak, but we didn't grow as strong as powerfully as we should. And had we started the current thrust of the last few years, including this engineering research center, earlier, we might have forestalled some of the great difficulty we've had in international competitiveness.

The NSF is a great success story throughout its history. It's had its ups and downs, in my view, and I have noted the up in these recent years, and I just hope that the current year across the government is a temporary thing. But I am delighted that NSF is doing as well as it can do.

Mr. WALGREN. You made a pretty strong endorsement of the policy view of NSF in your remarks, and yet that is where some of the focus is being taken off by the present budget.

Dr. STEVER. I am a little sorry about that.

Mr. WALGREN. How would you respond to that, though? Do you feel that even though we're all tempted to say thank you, that this committee ought not to say thank you but ought to underline the important functions that you perceive?

Dr. STEVER. I feel strongly that NSF again—NSF has kind of a position a little above some of those battles and can have a pretty broad view on these things like risk assessment and so on. It isn't

NSF itself. NSF supports the people in our society that do these studies, you know. NSF isn't allowed to do research in these things. It supports, it selects very good people to do the things that are needed for society. And because of that remoteness from actually doing things, I think they have a very broad judgment on quality and what should be done and so on. And I believe they can play a very important role in that.

In fact, during my time we strengthened, as you know, the policy part of it a great deal. STIA originated in our time. And while a lot of the policy decisionmaking is not within NSF, the studies, the data, the analysis, the evaluation, they can aid it so that other agencies and the White House and the Congress can make better decisions. I believe NSF can play a very important role here.

Mr. WALGREN. Thank you, Dr. Stever.

Mr. Boehlert.

Mr. BOEHLERT. Thank you very much, Doctor. You said that science in the pure form and science in the applied form are both important, and you expressed a concern that I share, that when we make a greater commitment to science in the applied form, we should view that as a supplement and not a replacement for our commitment in science in the pure form.

You know, the interesting thing that I experienced—and I will share a little story with you. You said in your testimony that we're not doing a good job in international relationships in science and technology. I just had an unusual experience. Right after the election, I was privileged to be a part of a U.S. congressional delegation to a NATO meeting in Brussels. And I was assigned by the chairman to the Science and Technical Committee, and the English and French—well, everybody just welcomed me with open arms because it was the first time in 4 years that we had a representative from our Congress sitting in that committee. I was very faithful and very diligent. I mean I loved Brussels and I love to see sights, but every single day I was at my post doing what I was told I was supposed to do, paying attention and trying to make some contribution.

I went back home and had issued a report, only to pick up my newspaper and really get blasted for junketing. You know, that's part of the problem. I couldn't agree more with you that we have to do a better job at strengthening our international relationships, and I think those of us who are on the political end of it have to be a partner to that effort. But we're getting so darned gun-shy we're afraid to go to any important meeting because we get labeled as junketeers. Speak out loud and clear.

Dr. STEVER. Well, I am very much—you know, we really are in a partnership effort, and you people over the years have played an unbelievable role in American science, and some of you have started out in science, but not too many, but here you do make it a major part of your career. And I think it's a very important thing that that partnership be seen all across the land and abroad, too, because of that joint thing.

None of us could do what we've done for science or in science alone. That just is true. And so I am for it.

May I tell you a story of one of your predecessors going to an international meeting, which I think you will remember?

Mr. BOEHLERT. I'd love it.

Dr. STEVER. The late Congressman Mosher, a very distinguished Republican Congressman from Ohio, went with me. I was the official representative at the Science Ministers meeting for the European Economic Community. Congress had a representative, and Mosher went there.

I had badly thrown out my back, and in the morning when I got up I found that I couldn't tie my shoes. So I went down to meet him for breakfast, and I asked him if he could tie my shoes. And as he bent down, I said, "This is the only time anybody from the administration has ever had his shoes tied by a Congressman." [Laughter.]

Mr. BOEHLERT. Good story.

Dr. STEVER. It was a wonder. And by the way, he contributed immeasurably. He spoke up, and it was great.

Well, Mr. Walgren, I thank you very much. On the science and technology together, and how close they are, since some people in this room are very close to the city of Pittsburgh and the home of the Carnegie-Mellon University, when I went there in 1965, there was a basic scientist by the name of Herbert Simon working on artificial intelligence. And I want to tell you there wasn't a person in the world who thought that was an applied science. It was a very basic consideration. Now, 15 or 20 years later, that is deeply involved in what Carnegie-Mellon University is doing in artificial intelligence and what many industries are doing in it.

That flow, a steady flow, is a very important feature of basic science and applied science and engineering and industry and so on that we have to understand, a very important thing to keep it strong across the whole range.

Mr. BOEHLERT. Thank you very much.

Mr. WALGREN. Well, thank you very much on behalf of the committee. We appreciate the resource that you represent, and we'll be talking with you often.

Dr. STEVER. Thank you.

Mr. WALGREN. Thank you.

That finishes the day. We will recess until 10 a.m. tomorrow.

[Whereupon, at 4:38 p.m., the subcommittee was adjourned, to reconvene at 10 a.m., Thursday, February 21, 1985.]

1986 NATIONAL SCIENCE FOUNDATION AUTHORIZATION

THURSDAY, FEBRUARY 21, 1985

House of Representatives,
Committee on Science and Technology,
Subcommittee on Science, Research and Technology,
Washington, DC.

The subcommittee met, pursuant to notice, at 10:04 a.m., in room 2318, Rayburn House Office Building, Hon. Doug Walgren (chairman of the subcommittee) presiding.

Present: Representatives Walgren, Wirth, Bruce, Mineta, Boehlert, Lujan, Ritter, Henry, and Cobey.

Mr. Walgren. Good morning, and let me welcome you here this morning.

Today the subcommittee holds the second and what we, at least at this point understand, is the closing hearing on our process for the National Science Foundation authorization, to look at the proposals for fiscal year 1986.

In yesterday's hearing, the subcommittee heard the views of several outstanding witnesses from other than the Federal sector. And today we have the Director of the National Science Foundation, Mr. Erich Bloch, and we have the Chairman of the National Science Board, Dr. Roland Schmitt, to give us further details on their perspectives on the proposals for the National Science Foundation in 1986.

We extend a special welcome to Dr. Schmitt, as this is his first appearance before the subcommittee as Chairman of the National Science Board. We look forward to talking with you, Dr. Schmitt, about a number of things as time goes on. As you know, we are especially interested in the rate of growth in the science and engineering education directorate and the opportunities in international scientific cooperation, initiatives in biotechnology, and others, and we know that the Board is very interested in those subjects. We would look forward, as a committee, to learning from you in that process.

Before we also start, I want to extend our congratulations to Mr. Bloch on being named this week as one of the first recipients of the National Technology Medal, a medal that's awarded by the President but created by the Congress. But for this institution, there would be no medal. Mr. Bloch was awarded this medal by the President, as I understand it, for your involvement and the work that you did on the development of the IBM system 360 computer and that certainly is a significant contribution you've made, and that recognition is very well deserved.

Let me ask if there are other Members that would like to make any opening comments.

Mr. **Boehlert**. I just would also like to welcome Mr. Bloch and Dr. Schmitt and add my congratulations to our very distinguished recipient of the first medal from the President for technology.

I would also add that I view this year's authorization process as a very pleasant experience because we're going to be working cooperatively and it won't be like in so many other instances in this Congress these days, cut, cut, cut, and cut some more. I think we're rather receptive to hearing that they are adding a little bit, and I look forward to your testimony.

Mr. **Walgren**. Mr. Lujan?

Mr. **Lujan**. I have no opening statement. I will wait until the questions.

Mr. **Walgren**. Thank you.

Well, gentlemen, welcome to the committee. We appreciate the effort that you give to making these presentations. Let me say at the outset that written submissions will be made part of the record automatically and reproduced to be worked with by other members and the staff and the public. So your written statements will be part of the public record and we would encourage you to focus our attention by summarizing or otherwise highlighting and outlining the important points that you feel deserve real attention.

I'd like to say the subcommittee has received statements regarding the fiscal 1986 NSF budget from other organizations and, with unanimous consent from the other members, these statements will also be made part of the record so that we have a complete body of work to refer to.

But with that, let me welcome you and please proceed, Mr. Bloch, as you feel most effective in focusing our attention on what we should think about.

STATEMENT OF ERICH BLOCH, DIRECTOR, NATIONAL SCIENCE FOUNDATION

Mr. **Bloch**. Thank you, Mr. Chairman, and thank you and the members for your congratulations. It was a surprise to me, but I must say it was for work that was long in the past, and probably obsolete by now.

As you mentioned, I have a written statement, but I will only summarize the pertinent points.

The first thing I would like to address is the role of NSF, and it's a very simple but very important kind of role, namely, to ensure the health of the U.S. scientific enterprise. We are doing that through the support of the most promising basic research in science and engineering.

The products in general that we are producing are new knowledge and discoveries and, in particular, education and training of the most talented scientists and engineers.

I hope that the activities that we are pursuing have a wide impact. They certainly impact the Nation's economy as well as its research competitiveness. It affects defense and the general well-being of the citizens of this country.

Before I get into the details of the testimony, I would like to introduce Dr. Roland Schmitt, the chairman of the National Science Board and vice president of research and development for GE, and I think he has a few comments which he would like to make.

[A biographical sketch of Dr. Schmitt follows:]

Dr. Roland W. Schmitt
Senior Vice President - Corporate Research and Development
General Electric Company
Schenectady, New York 12301

Dr. Roland W. Schmitt is the General Electric Company's Senior Vice President for Corporate Research and Development and a member of the company's Corporate Executive Council. He directs the Schenectady, N.Y.-based GE Research and Development Center, one of the world's largest and most diversified industrial laboratories, with activities in Singapore and Sao Paulo, Brazil, as well as offices in London and Zurich. At this corporate-level facility, some 2,100 people – including more than 1,000 scientists, engineers, and technicians from virtually every major scientific and engineering discipline – concentrate their efforts on the company's longer-range R&D needs, performing advanced studies in chemicals, electronics, engineering physics, and materials.

Dr. Schmitt is serving a two-year term as chairman of the National Science Board, the policy-making body of the National Science Foundation. The Board – comprised of 24 part-time members who represent the nation's scientific leadership – assists in the formulation of national science policies. In addition, he is a member of the National Academy of Engineering and serves on its Council.

In recent years, Dr. Schmitt has overseen a $170 million expansion program that has increased the Research and Development Center's physical size by 50% and stocked its new laboratories with state-of-the-art research equipment. The centerpiece is a structure housing one of the world's most advanced electronics laboratories.

A native of Seguin, Texas, Dr. Schmitt received his undergraduate degrees in physics and mathematics from the University of Texas and his Ph.D. in physics from Rice University. He joined the General Electric Research Laboratory (now part of the Research and Development Center) in 1951 and was initially engaged in research studies involving low-temperature physics, metal physics, and transport phenomena.

In 1957, Dr. Schmitt assumed his first managerial position as head of a team of GE physicists and metallurgists. During 1965, he served as a visiting research associate at Harvard University. He was named Manager of the Metallurgy and Ceramics Laboratory at the Research and Development Center in 1966, R&D Manager of Physical Science and Engineering in 1968, R&D Manager of Energy Science and Engineering in 1974, Vice President of Corporate Research and Development in 1978, and to his present position in 1982.

Dr. Schmitt is a Fellow of the American Physical Society, the Institute of Electrical and Electronics Engineers (IEEE), and the American Association for the Advancement of Science, and is a member of the Board of Directors and Vice President of the Industrial Research Institute. He is a past member of the Governing Board of the American Institute of Physics and the Energy Research Advisory Board of the U.S. Department of Energy. He also has served on panels of the National Bureau of Standards, the National Research Council, and the Office of Technology Assessment. In 1977, he was presented with the IEEE's Region I Award for Electrical Engineering Management.

In the area of education, Dr. Schmitt is on the Board of Trustees of Rensselaer Polytechnic Institute and the Trustee Board of Advisors of Union College. In 1982, he was presented with the former's Community Service Award. He is a past member and vice chairman of the Board of the New York State Science and Technology Foundation. Locally, he is a member of the Board of Directors of Sunnyview Hospital and Rehabilitation Center.

5/30/84

STATEMENT OF DR. ROLAND W. SCHMITT, CHAIRMAN, NATIONAL SCIENCE BOARD

Dr. SCHMITT. Thank you, Erich.

Mr. Chairman and members of the subcommittee, as Erich said, I am Roland Schmitt, senior vice president for corporate research and development at General Electric and chairman of the National Science Board, and it's in the latter capacity that I am testifying here today.

I really feel it a great pleasure to join Erich Bloch in appearing before you today to discuss the authorization of the fiscal 1986 budget for the National Science Foundation. What I would like to do is summarize some of the science and engineering policy issues that bear on the strategy behind this budget, and some of the priorities that it does address.

This committee is certainly aware that the Nation today faces heightened international competitive challenges in both the economic, the military, and the technological realm. And this competition broadens, quite substantially, the demands on science and engineering research and education. These pressures truly make it more important than ever before to strengthen the science and engineering base that underlies all of our technology efforts. That base determines the ability to perform forefront research and to renew the Nation's supply of first-rate scientists and engineers. But at the very time that demands are greatest, we do face the prospect of deteriorating research and education capabilities in our great universities due to shortage of faculty and of up-to-date equipment facilities for instruction and research.

The Federal Government plays the leading role in supporting universities in their efforts to do research and provide personnel for the future. So, even in the time of necessarily constrained budgets and very, very hard choices among many worthwhile goals, the President's fiscal 1986 budget attaches significant priority to continuing need for strengthening the academic science and engineering base on which the Nation's economic and military security truly depend.

This need is being met by several recent initiatives that provide new environments and new capabilities for strengthening research and education. The National Science Foundation has begun the process of creating engineering research centers, which is a new form of university-industry cooperative research effort that puts cross-disciplinary teams of engineering faculty and undergraduate and graduate students to work on problems that combine both intellectual excitement and economic value.

The concept has received very strong support from the President's Science Advisor, the National Science Board, the National Academy of Engineering, and industry. I truly urge your continued support of this new concept for gaining fundamental engineering knowledge while educating future engineers.

Another such initiative is the plan to establish advanced scientific computing centers to enhance progress in many areas of science and engineering research and education. The computing revolution has created dramatic improvements in all aspects of doing science and technology, from experimentation to computer modeling to computer-aided design and engineering. And strengthening that science and engineering base requires making sure that the next generation of scientists and engineers can, in fact, use these tools and use them well.

The proposed centers are being judged, in part, on their close involvement with high quality research projects and their educational value in teaching students and researchers to use the most advanced computers. At its meeting tomorrow, the National Science Board will consider recommendations of the director for the initial centers.

Universities continue to experience severe problems in obtaining state-of-the-art research instrumentation. In response to this need, NSF is continuing to increase support for instrumentation at all levels, from individual projects and investigators to national centers serving hundreds of scientists and engineers. First-rate instrumentation is absolutely essential, both for research and also for the education of tomorrow's innovators and investigators.

Another major initiative, the Presidential Young Investigators Program, addresses the problem of faculty shortages. Universities need outstanding scientists and engineers in teaching positions if they hope to turn out outstanding graduates in science and engineering. But retaining those teachers is difficult, given the high demand for their skills in nonteaching jobs. The Presidential Young Investigators Program provides a big incentive for staying and teaching—NSF research funding and matching industrial support, up to a total of $100,000 a year for 5 years. The Nation's engineering and science communities and its advanced-technology industries strongly support this program, and I also urge your continued strong support for it.

Science and engineering education also needs strengthening, particularly at the precollege level. As many of you know, this need has been voiced in many recent reports. The NSF is responding with new efforts to strengthen its science and engineering education programs, as Erich Bloch will describe to you in a moment. The National Science Board, again, strongly supports those efforts.

And finally, the past decade has witnessed a phenomenal expansion in biological science and technology, and continued American leadership here will depend on the strength of the science and engineering base. In response, the NSF is undertaking an initiative that will support biotechnology-related research underlying such goals as the improved growth and utilization of food and fiber crops, better medicines and diagnostic techniques, and improved production of specialty chemicals. The initiative will also support the education of bioengineers that are needed to assist the turning of basic knowledge into practical processes and products.

Well, those are some of the initiatives meeting what I regard as NSF's top priority, strengthening the Nation's science and engineering base.

I will conclude by describing how we have restructured the National Science Board to increase its involvement in developing NSF policy and in national science policy in general.

To help the Foundation respond to human resource needs more effectively, we have established a Committee on Education and Human Resources to oversee the Foundation's efforts in science and engineering education. It will also address science and engineering personnel issues, including efforts to bring minorities, women, and the handicapped into science and engineering careers.

To oversee NSF long-range planning and program implementation more effectively, we have established a Committee on Programs and Plans. We want to move away from reliance on approval of awards as the primary mechanism for the oversight of NSF programs. As you know, the National Science Foundation Act requires that the Board approve awards above fixed amounts in the statute. We are seeking your support of an amendment to the NSF Act that would eliminate any set specification in law of an amount above which the Board could not delegate approval authority to the Director. We believe that by reducing the number of individual grants we are required to review based solely on the dollar limit, that we could spend more of our time reviewing programs with special policy significance, such as the initiatives that I spoke of previously, and we will be able to get involved earlier in the decision-making process.

We have worked very closely with Erich Bloch in developing the recent changes in the Board's structure with the aim of involving the Board more fully in the substance of the Nation's science and engineering policy level problems, opportunities, and also the issues. The National Science Board can truly be only as effective and as useful as the Director of NSF wants it to be. And I must say that this Director has made it very, very clear that he wants an active and a strong Board, and it is a pleasure to work with him.

Finally, let me give you some examples of the tasks that the Board will take on during 1985. At the broadest level, we will work with the Director to develop NSF's goals, organizational philosophy, and future program directions. Our exchanges with this committee, as it undertakes its 2-year science policy review, will be an important factor in this regard. We will also examine changes in the institutional framework for supporting university-based science and engineering, NSF's role in fundamental computational science in relation to other agencies, and the development of the initiatives I have just reviewed—science and engineering education, engineering research centers, advanced scientific computing, and so on. We will also continue our reviews of science in the international setting, and of research excellence and of the breadth of research participation. The question of how we can foster and maintain excellence in our research universities in the context of national needs and priorities is one that we must all address.

The Board looks forward to working with Erich as he tackles these tasks and implements the strategic directions for the National Science Foundation that you have supported in recent years. I would now like to turn back to Erich for his testimony and later I would be glad to respond to any of your questions.

Mr. BLOCH. Thank you, Roland.

Obviously, Mr. Chairman, the main topic this morning is the budget and I intend to dissect the budget for you from many different viewpoints and many different angles.

Before I do that, I think it would be advisable to talk about three general areas.

The first one I would like to highlight for a minute are the challenges that the research enterprise is facing today. First of all, there is increasing complexity of what research is all about and what research does. Not just in the problems which are being solved or trying to be solved, but in the process itself that is being employed to do the research and the instruments which are required to perform the research, as well as in the techniques and the technologies which have to be brought to bear on it.

And this, I think, leads to a breakdown of walls between disciplines, and we see that, certainly, in the biotechnology area, which today is certainly a mixture of science as well as chemical engineering and discipline aspects. You see it in material science, where it's really difficult to distinguish between science and engineering in that area, and one sees it in the total engineering enterprise which is really less of a discipline-oriented enterprise today than it was before, but more of an interdisciplinary enterprise, not only dragging in some of the inputs from some of the various engineering disciplines, but certainly from the science disciplines as well as from the soft sciences such as economics and so forth.

The accelerating rate of change is another observation that one has to make. I think by any measurement that we can put to bear on this particular problem, the rate of change that is occurring today is greater by any measure than it has been in the past.

With it comes a lack of resources or scarcity of resources, both the human resources that we have to bring to bear on the problems themselves as well as the financial resources in terms of equipment and facilities.

I think a second point that needs to be made in this area of challenges for research is that of world competition. We are talking many times about economic world competition, but there is such a thing as competition in research, as well. And I think the industrial nations and emerging nations, especially our trading partners, recognize increasing the basic role of research for the well-being of their nations, and we can no longer take for granted the preeminence in science and engineering that the United States enjoyed for such a long time. I don't mean to indicate that we have lost that preeminence; not at all. But I think the gap is narrowing and I think we have to be aware of the fact that we are being challenged in this very vital research and engineering area.

There is resolve today to meet these challenges. I think the public is aware more than in the past of the role of science and technology and the importance of science and technology; certainly Congress and the administration are well aware of that. And there is more cooperation between academia, Government, and industry than there was in the past where it was more of an adversarial kind of relationship. And I think that is to the good of all the actors in this particular area.

The second subject I think I would like to highlight are some of the NSF goals and strategies that we have in place. Obviously, they must be in support of Congress and the administration policy. We have a hallmark of excellence in NSF which we must maintain and maintain very strongly. That is true both internally, what we do inside NSF, as well as the funding that we are providing to the most important questions and institutions that are doing the work in the research area. Excellence is the prime motivation for us and leads everything else.

NSF must be a catalyst for change. I don't think we can just sit back and let things happen to us; we have to single out new research opportunities, new ways for approaching research and making sure that we understand the trend that is occurring, and that we are meeting the trend and not following the trend.

Our motivation also is to improve the health of the science and engineering infrastructure and we have focused very heavily, as I hope I can show you in a few minutes, on instrumentation and also somewhat on facilities.

But the human resources—attracting and educating and training students—is probably the most important aspect of our job.

And last but not least, we need to try and look for ways of leveraging Government funds with that of industry and also institutions, because no matter how much money we have it's never enough to do all the research that should be done. So leveraging the funds is a very important kind of subject.

Now, let me get to the main topic, mainly, the 1986 budget itself. Within the framework of fiscal restraint, the NSF budget reflects, I think, the high priority that the administration and the Congress attaches to the science and engineering research enterprise. And as a consequence, what you mentioned before, Mr. Chairman, we are seeing a slight increase in the total funding for NSF. But let me make sure and point out that the additional funding that we have received from the administration has to be spent wisely and it has to be leveraged internally in the Foundation.

As a consequence of that one, we have taken on the job and we have put the budget together with the following ground rules in mind.

Item No. 1, we wanted to lower our administrative costs that we are incurring ourselves. And let me just say, at the outset, that I have been impressed, coming in new to the Foundation, that the administrative costs were way lower than what I would have expected from an organization of this sort. But I think, nevertheless, one can make some additional kind of savings, and that is reflected in the budget.

Second, we have to curtail programs that are not in the mainstream of activities, programs that at one time were very important and that have lost some of their timeliness, because I don't think we can always depend on increases to start up new programs. We have to find the funding from within, many times, of doing that, and we have tried to do exactly that.

The third thing which we try to do is to stretch out large capital investments up to a point—up to a point where this won't hurt us in the total—in order to make more dollars available for people that are doing the research, and for the research itself. So you see, within the whole budget, the stretching out of capital investments.

We had to make tradeoffs with programs of lower priority in order to support the new initiatives. And as far as the new initiatives are concerned, I just want to state that starting an initiative one year, one has to really follow through on it in order to see it come to full fruition. And we try to focus on that problem in a very particular kind of way.

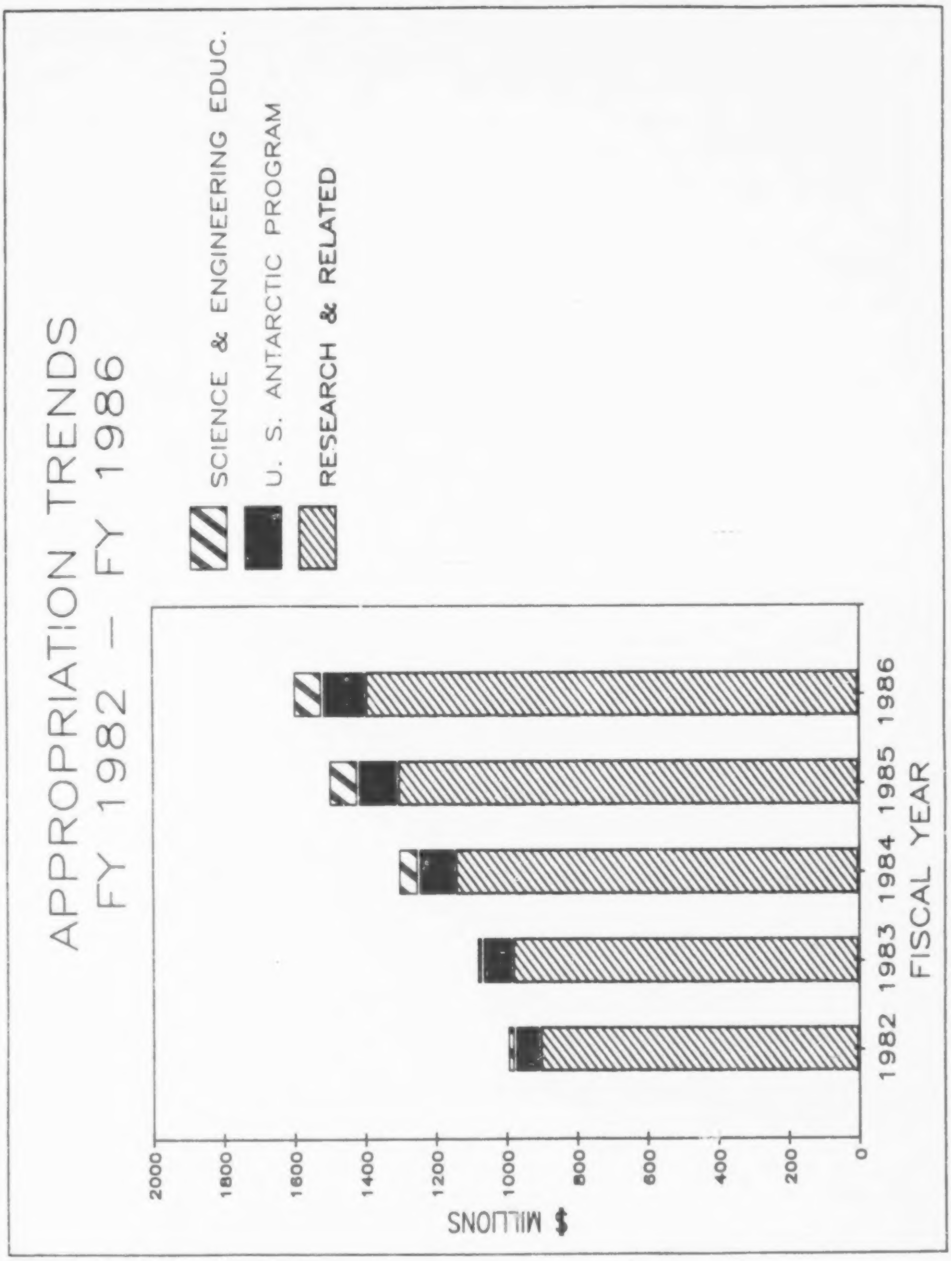
Last but not least, we did not undertake any new major starts, any new major program starts, within this particular budget for exactly the reason that the dollars were not available in order to do that.

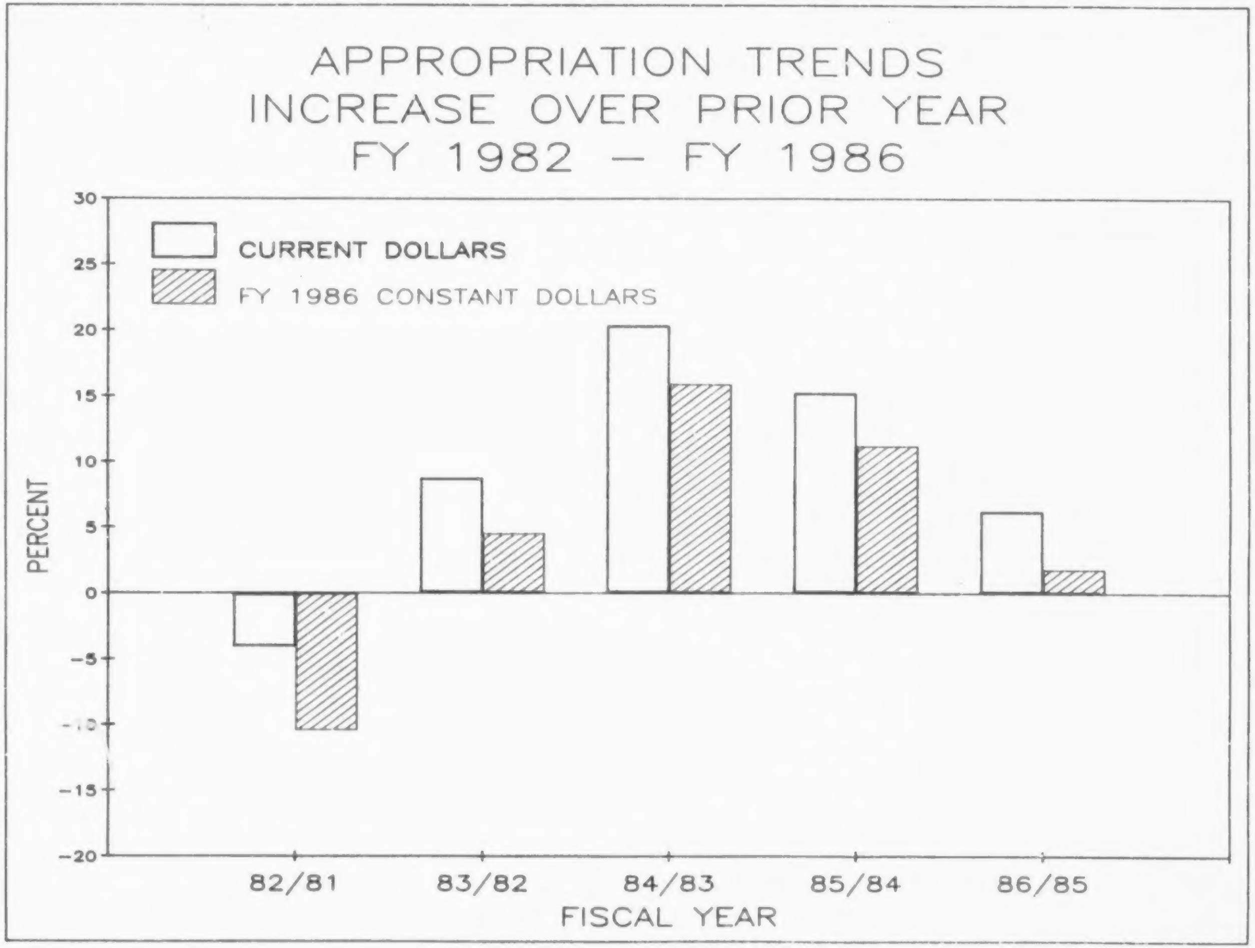
So those were the ground rules that we followed in studying the budget.

Let me say one thing in general before I get into the details on the budget. In my opinion, it's a well-balanced budget and any changes within the budget have some major kinds of repercussions, so I really would like to urge you to look at the budget in that particular sense; that it's not a budget where everybody got an 8-percent increase. But we really tried to single out the most important areas, balance it in such a way that we have a good, overall kind of a budget that will help us in 1986, carry us through 1986, but the budget has interdependencies built in. I just wanted to make this point.

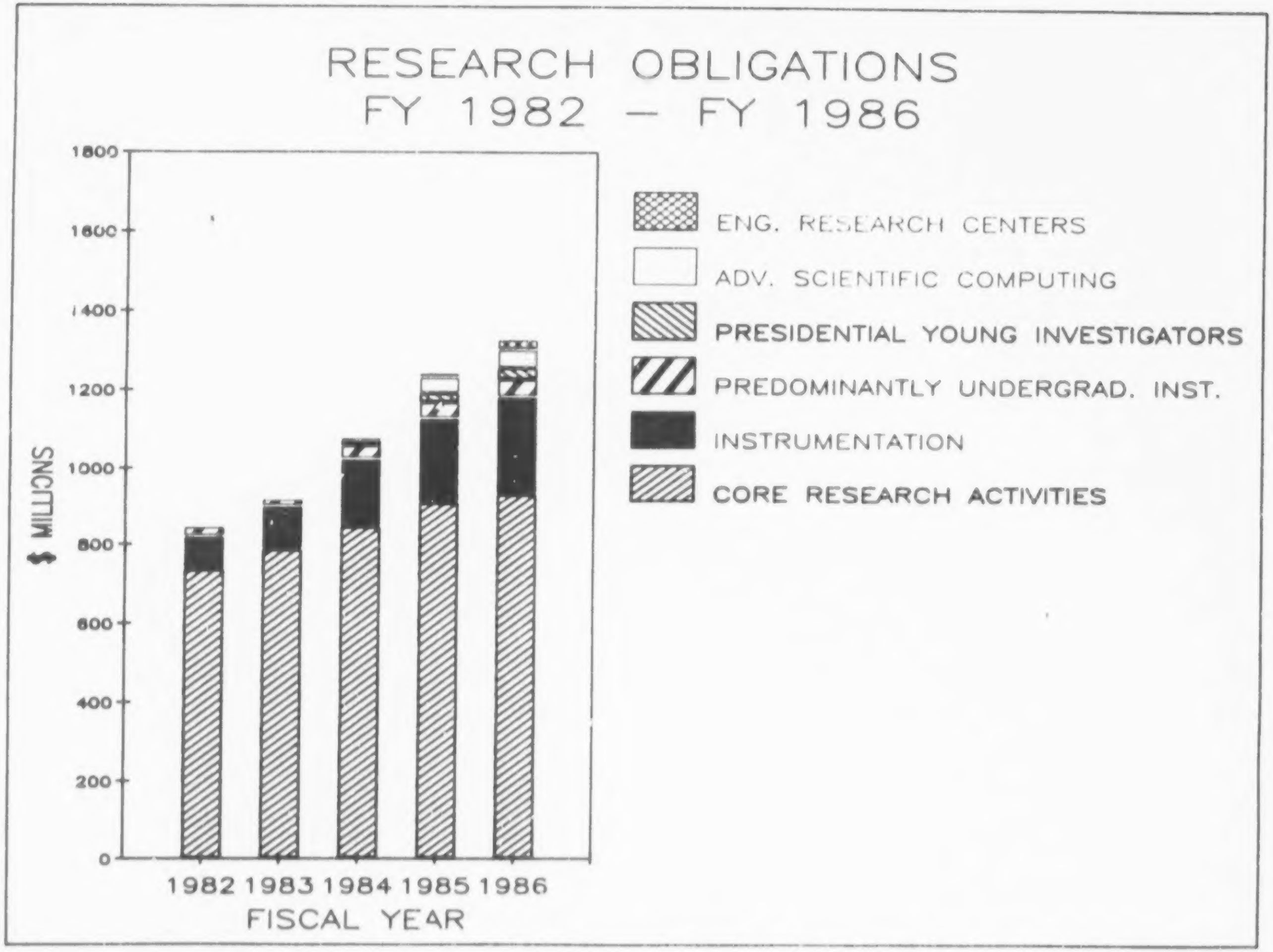
Now what I would like to do is go through the budget in fair detail with you and, in order to do that, we have some foils here which we are projecting. You have in front of you copies of these foils, which you can follow. I will tell you the ones that I'm going to talk about.

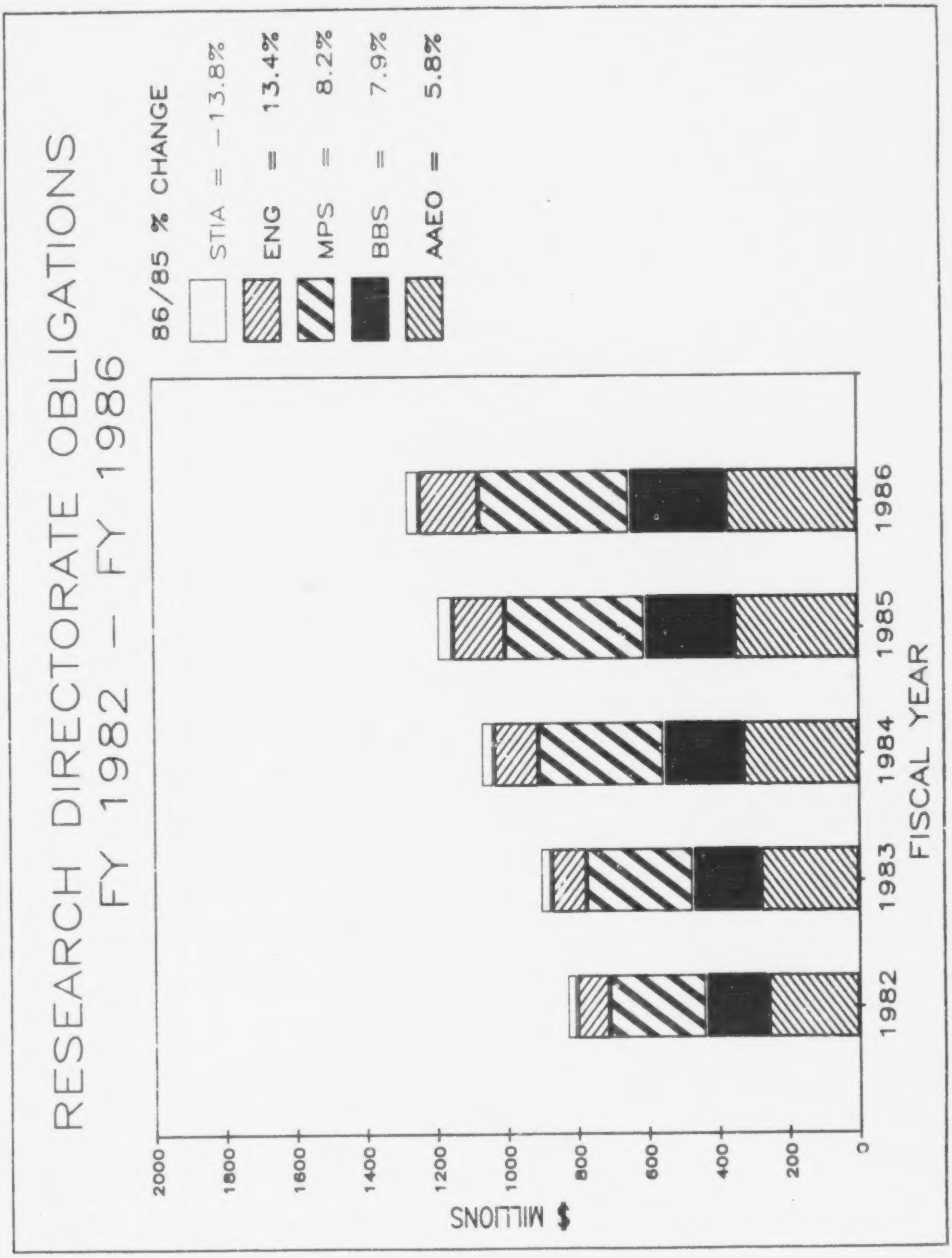
[Graphic handout follows:]

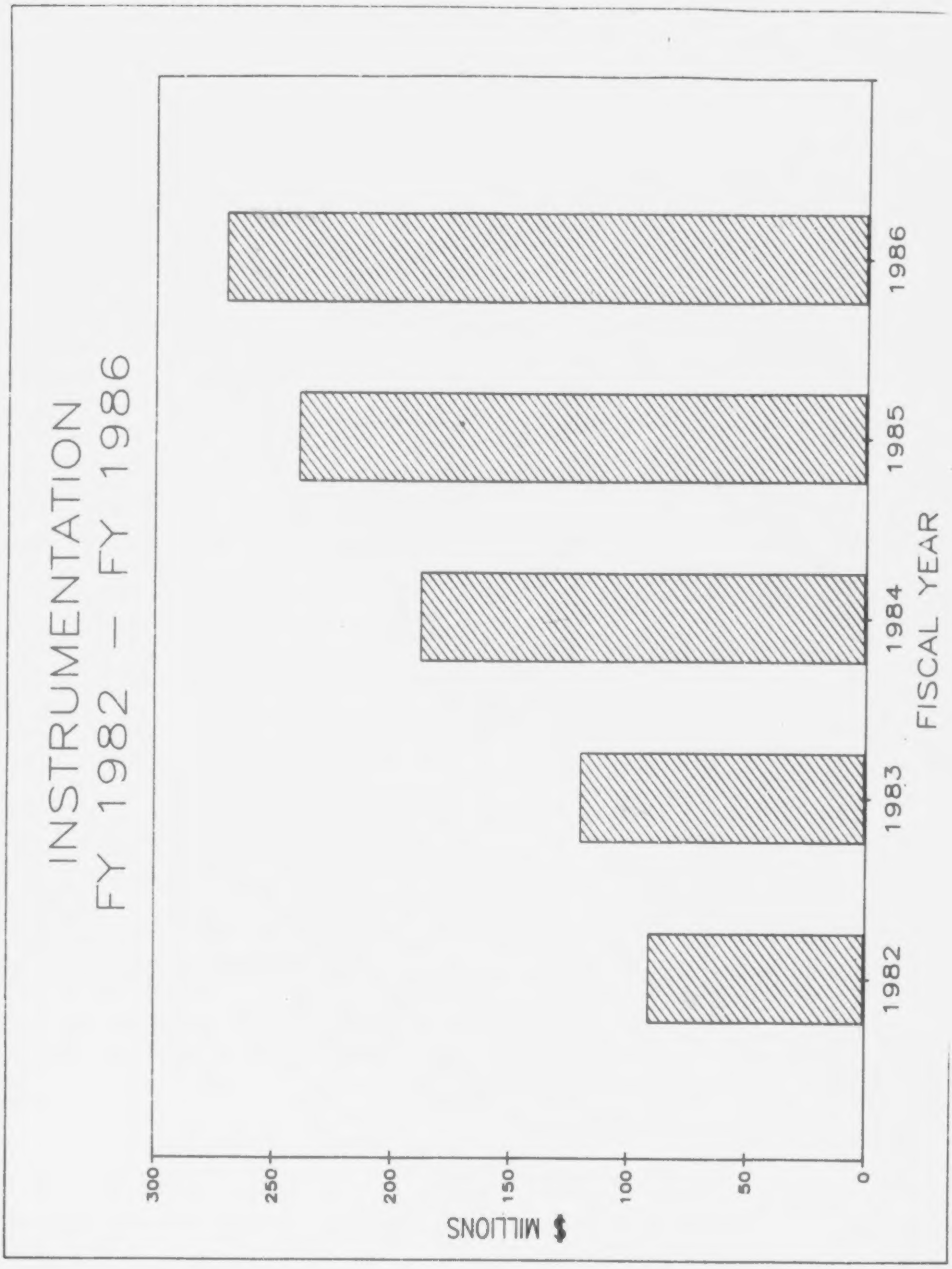

APPROPRIATION TRENDS
FY 1982 — FY 1986
SCIENCE & ENGINEERING EDUC.
U. S. ANTARCTIC PROGRAM
RESEARCH & RELATED
$ MILLIONS
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1982
1983
1984
1985
1986
FISCAL YEAR

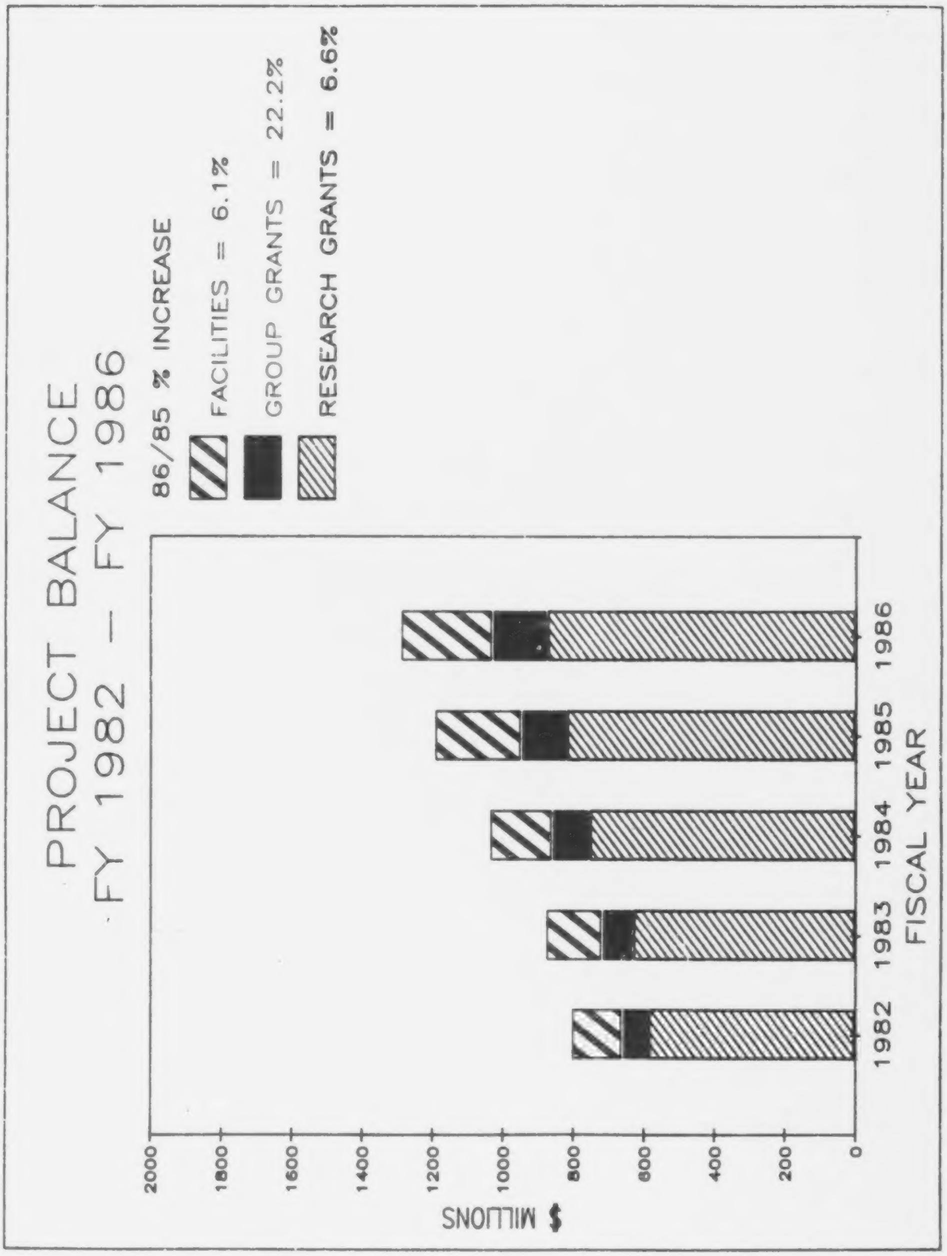


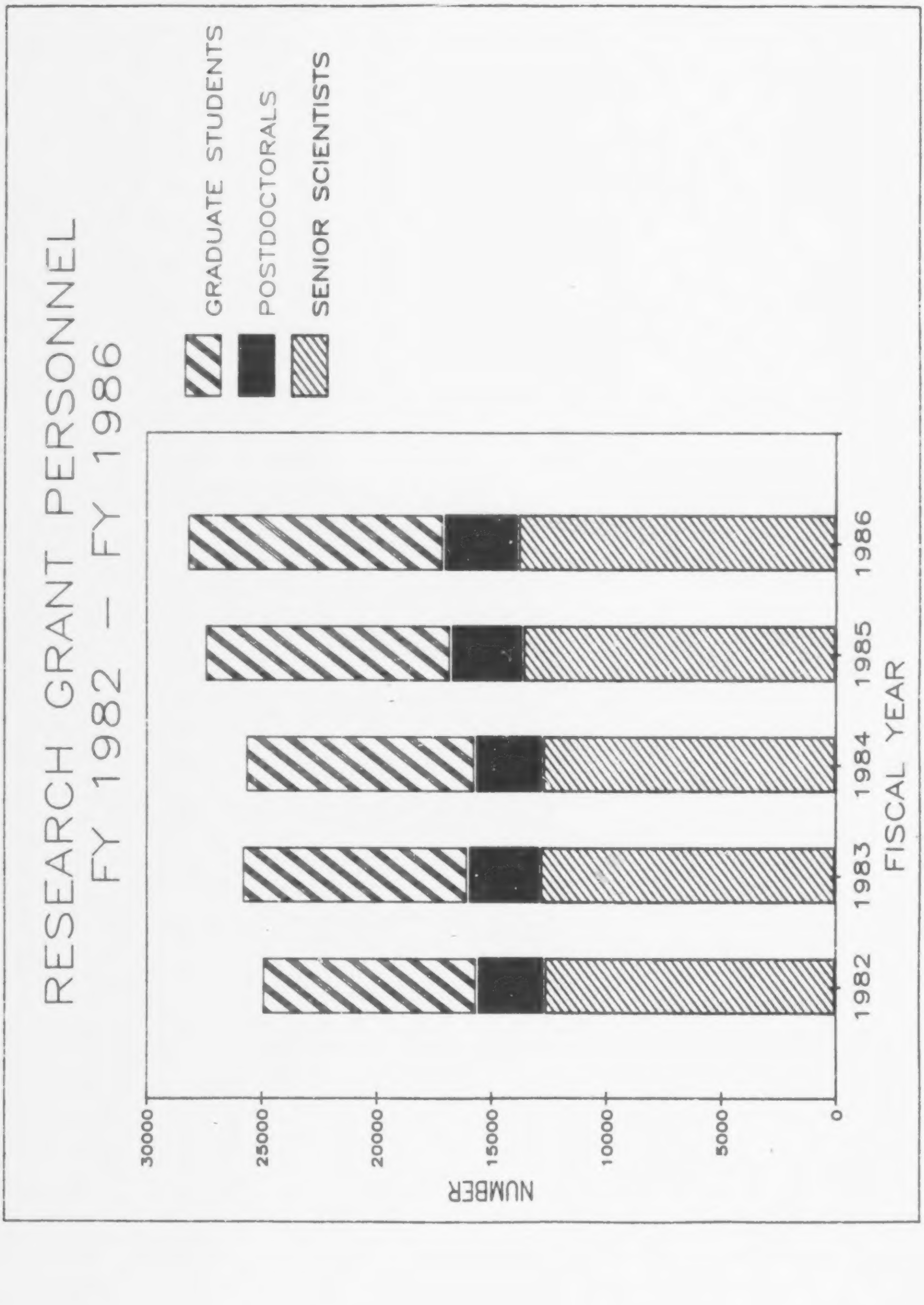
APPROPRIATION TRENDS
INCREASE OVER PRIOR YEAR
FY 1982 – FY 1986

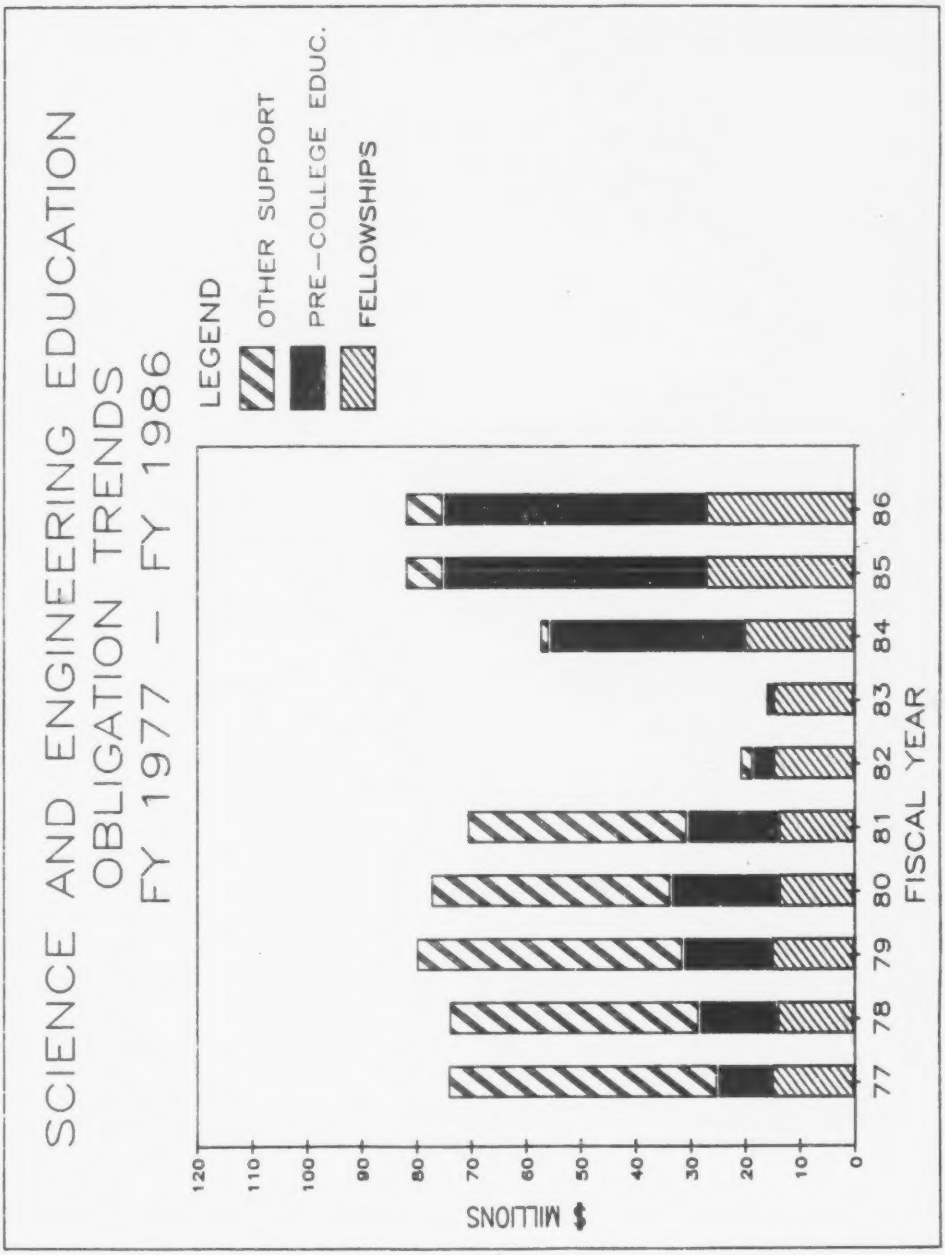

RESEARCH OBLIGATIONS
FY 1982 — FY 1986
$ MILLIONS
0
200
400
600
800
1000
1200
1400
1600
1800
1982
1983
1984
1985
1986
FISCAL YEAR
ENG. RESEARCH CENTERS
ADV. SCIENTIFIC COMPUTING
PRESIDENTIAL YOUNG INVESTIGATORS
PREDOMINANTLY UNDERGRAD. INST.
INSTRUMENTATION
CORE RESEARCH ACTIVITIES


RESEARCH DIRECTORATE OBLIGATIONS
FY 1982 – FY 1986
86/85 % CHANGE
STIA = −13.8%
ENG = 13.4%
MPS = 8.2%
BBS = 7.9%
AAEO = 5.8%
$ MILLIONS
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1982
1983
1984
1985
1986
FISCAL YEAR


INSTRUMENTATION
FY 1982 – FY 1986
$ MILLIONS
300
250
200
150
100
50
0
1982
1983
1984
1985
1986
FISCAL YEAR

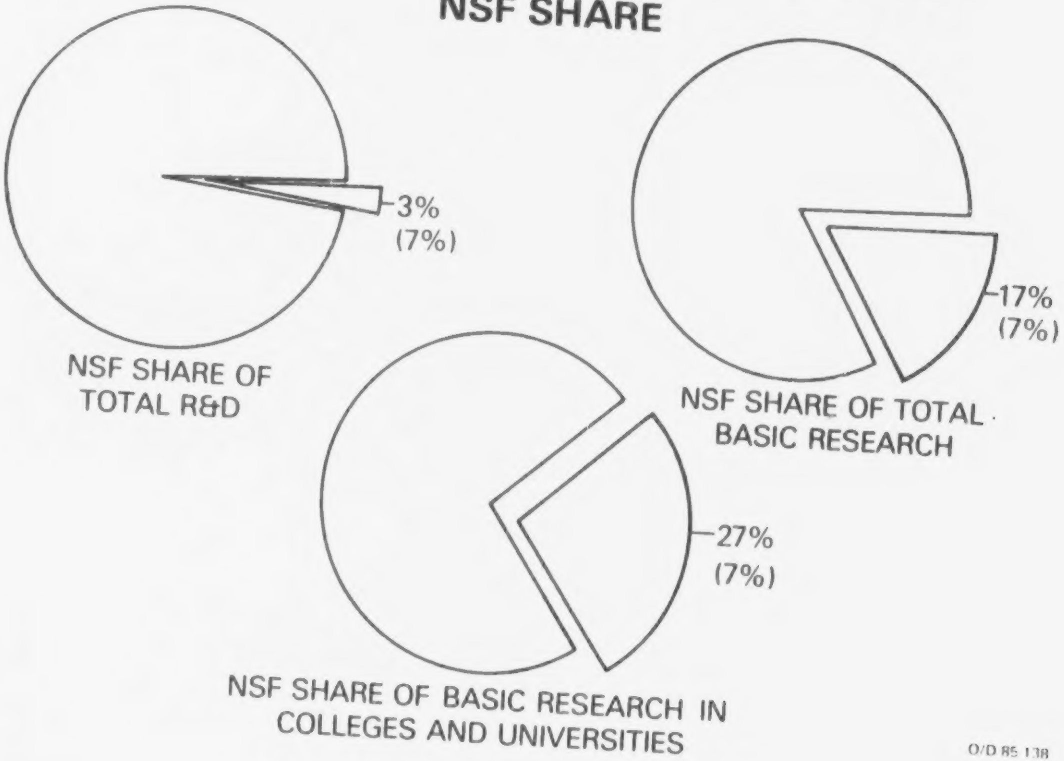

PROJECT BALANCE
FY 1982 – FY 1986
86/85 % INCREASE
FACILITIES = 6.1%
GROUP GRANTS = 22.2%
RESEARCH GRANTS = 6.6%
$ MILLIONS
0
200
400
600
800
1000
1200
1400
1600
1800
2000
1982
1983
1984
1985
1986
FISCAL YEAR

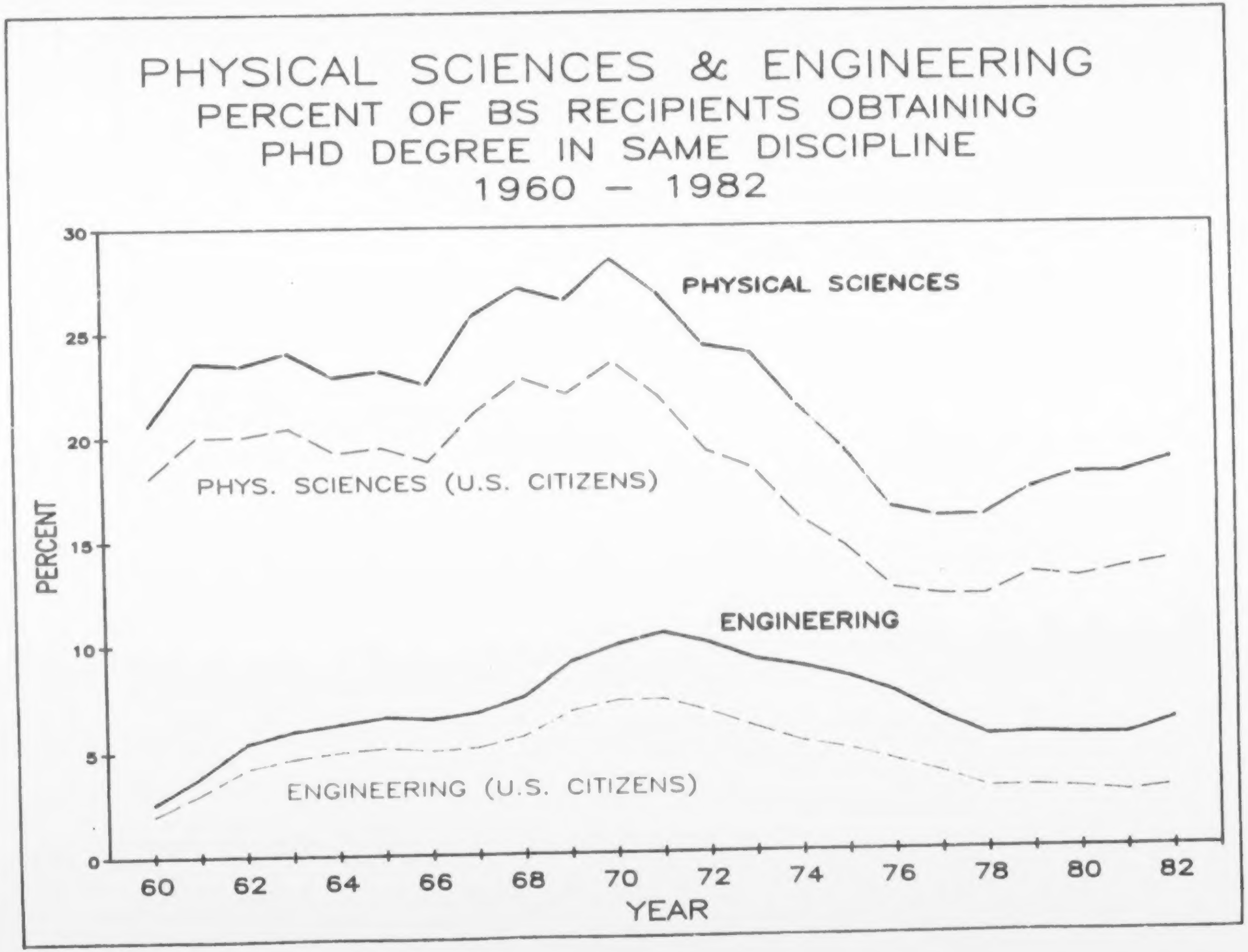

RESEARCH GRANT PERSONNEL
FY 1982 – FY 1986
GRADUATE STUDENTS
POSTDOCTORALS
SENIOR SCIENTISTS
NUMBER
30000
25000
20000
15000
10000
5000
0
1982
1983
1984
1985
1986
FISCAL YEAR


SCIENCE AND ENGINEERING EDUCATION
OBLIGATION TRENDS
FY 1977 — FY 1986
LEGEND
OTHER SUPPORT
PRE-COLLEGE EDUC.
FELLOWSHIPS
$ MILLIONS
0
10
20
30
40
50
60
70
80
90
100
110
120
77
78
79
80
81
82
83
84
85
86
FISCAL YEAR

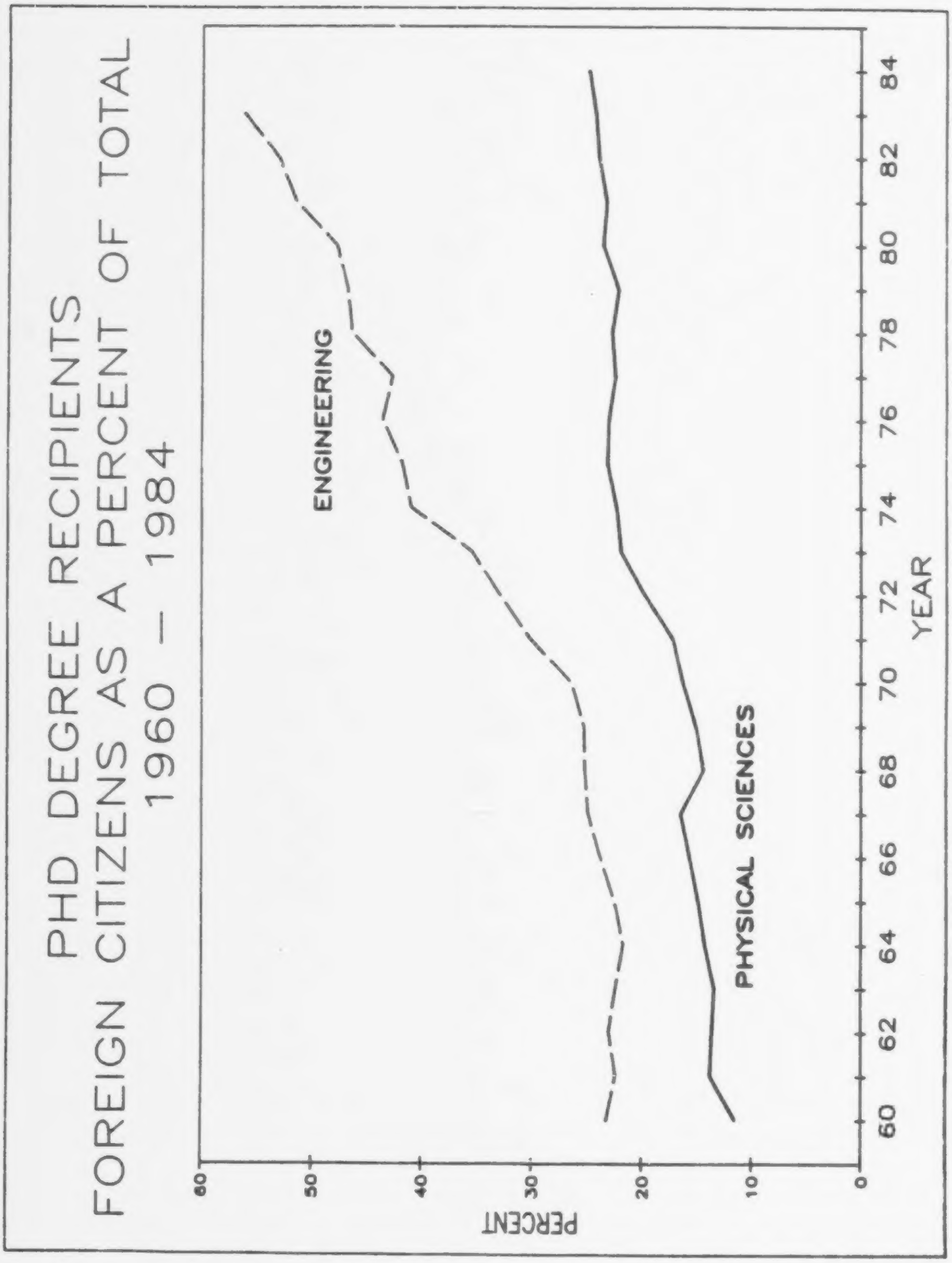
FEDERAL SUPPORT FOR CONDUCT OF RESEARCH AND DEVELOPMENT, FY 1986

NSF SHARE





PHYSICAL SCIENCES & ENGINEERING
PERCENT OF BS RECIPIENTS OBTAINING
PHD DEGREE IN SAME DISCIPLINE
1960 – 1982



PHD DEGREE RECIPIENTS
FOREIGN CITIZENS AS A PERCENT OF TOTAL
1960 – 1984

Mr. Bloch. The first one is chart No. 1, which is called "Appropriation Trends," which should be the first one in your package. And here you see essentially the whole story of the NSF budget since 1982. The research and related activities area, which is the major activity of the Foundation, has had a 54-percent increase since 1982 and even in 1986 you see a significant increase in that particular area.

The second area is the U.S. Antarctic Program, and it has grown, as you can see, since 1982; it has approximately doubled because of our central role in coordinating all research activities in Antarctica, a responsibility that has been transferred to the Foundation by the President in 1983, and most of the funding has gone for equipment and facilities in that region. It's a very expensive region to do research in, and that is reflected in this particular budget.

The last area is the science and engineering education area which, again, has seen increases from 1982 through 1986. I will talk some more, and in great detail, about this particular area. It's a very important area, No. 1, and the changes and the decisions we had to make are very complex ones and I want to make sure that you understand some of the reasons behind it.

The second chart that I want to show you is essentially—again, it's the appropriation trends from 1982 through 1986, and you see in both current dollars and in constant 1986 dollars the increases that we had over the last few years, and the 1985 to 1986 change which, in current dollars, is about 6 percent—that's the bottom line—and in constant dollars is about a plus 2 percent. It's a decreasing increase from 1983 through 1984 through 1985, as you can see, but nevertheless it is a real increase by any terms that you can bring to bear on it.

Next one.

The next point that I want to make is on the research obligations themselves. Again, you see the trend from 1985 to 1986, and the first one that I want to focus on is the core research activities, which has an increase of 26 percent going over this particular time period.

Instrumentation—and I will focus on that one separately—has increased about 300 percent since 1982, and that is really due to the fact that we need to focus on instrumentation. The instrumentation in our colleges and universities is behind the state of the art, and that's why you see this extraordinary focus on instrumentation.

There are several initiatives that are started, have been started and are well on the way. The first one is the predominantly undergraduate institution initiative, which is up 76 percent over this timeframe to $44 million in 1986. It focuses on 4-year colleges and 4-year universities.

As the Presidential Young Investigator Award is a relatively new program, entering its third year in 1986—and it will encompass, in 1986, 500 of the finest young science and engineering Ph.D.'s that we can single out in this country for very adequate and extensive support over a long period of time, namely, 5 years. Our commitment is for 5 years; it's for $100,000 per year, which has to be matched by a certain amount by industry.

The other area that I want to talk about is advanced scientific computing, which you see here, which is a relatively new program starting in 1984, 1985, and 1986. In 1985 it's about $40 million and it has an increase of about $6 million to $46 million in 1986. It will allow us, between those 2 years, to put in place four centers, and I think that is an adequate start for this particular program.

The last area is the engineering research centers that are shown on this particular chart, which we are just starting off this year with a $10 million allocation which will climb to $25 million next year. It will supply and will allow us between 1985 and 1986 to have up to about 10 centers that are providing opportunity for cross-disciplinary teams doing the research that is necessary in support of industry and in support of the research base that is so important in the future.

The next graph shows the research directorate obligations by area. And you see that each of the research directorates has gotten a significant increase this year, ranging from 5 percent to as high as 12 percent for engineering. That's obviously in recognition of the programs that are being supported by these directorates. The one that I am not showing on here is the Directorate for Scientific, Technical, and International Affairs which also has seen increases since 1982 but, in 1986, is down somewhat by a certain amount in order to do some of the other programs that I have been describing.

The next chart talks about instrumentation, and I said I would focus on that one specifically. Here it shows it essentially all by itself, going from $90 million to $270 million in 1986. About 20 percent of every dollar spent on research in the National Science Foundation flows into instrumentation. And probably it's insufficient; I'll say that right at the outset. But I think that's about the only thing we can afford within the constraints of the budget that we have. It's a very important area. I think this kind of spending for instrumentation will be with us in the future because I believe that the instrumentation question will not be solved overnight, No. 1, and also because of the accelerating progress that I mentioned before in instrumentation in particular. We've got to make sure that we supply to our colleges and universities the best equipment in order to be able to do the best research. So I think this particular problem will be with us for some time. I think the Foundation has focused on it in the right way; and again, the high dollars that we are spending on instrumentation is an indication of its importance to us and to the people that we serve.

The next area, item 7, has to do with the balance within the Foundation itself. And what I'm showing you here is essentially the percent of the dollars that are going into the research grants; you see that's about 70 percent, and that's really primarily addressing individual research.

The second area that you are seeing here is group grants, which is 12 percent, and the third area is the facilities areas, which are 18 percent.

There is a big concern that because of the interdisciplinary nature of many of our undertakings, because of big projects like ocean drilling, for example, that we are neglecting the individual researcher. We have to focus on this particular problem within the Foundation, and the Board has to focus on it, and let me assure you that we are very much concerned about it and that we are not going to let that happen.

If you look at this 70-percent number that exists in 1986 and go back a few years, it has dropped somewhat, but it only has dropped maybe 2 or 3 percentage points. So our focus is very much concerned with the individual investigator; but nevertheless, we have to have a balance between large programs and small programs, between big science and small science.

The next area talks about support for people, and in particular senior scientists, postdoctoral people, and graduate students. And we have had a continuous increase, a small increase, in the number of people we are supporting. This is a numbers chart; it talks about the number of people. We are supporting about 13,800 senior scientists, about 3,000 postdoctoral, and about 11,000 graduate students, and this year the increases in the number of people, I think, are kind of significant; they are on the order of about 10 percent of the people that we are supporting.

Let me just make one other point. Over the last few years, over the last couple of years in particular, the Foundation has increased the grant itself, the dollar grant per individual, to a significant level. It was $6,000; today it's about $11,000 and about $6,000 going to the research institution. And I think that's an adequate level at this point in time. At one point it was not adequate. We are not the highest one, by the way; there are also Government agencies that are paying more for a particular grant than we are paying—a small amount more, but I think this is what we can afford under the circumstances. And I think it's adequate for the purpose. Especially in the last year or so the inflation rate has leveled off, and I think that should be also an indication that we don't have to raise the grant amount this year. We raised it a couple years ago, and I think that was the right thing to do at that time.

The next graph, No. 9, has to do with science and engineering education, and I want to dwell on that one to great extent.

First of all, I think that it's very important that we look at the trend over the last decade because of the changes that have occurred in this particular area. Prior to 1982, the precollege and college level activities—the two areas that you're seeing—had numerous underfunded and fragmented programs. They were often not adequately coupled to each other or to State and local educational programs. In 1982, as a consequence, the funding was virtually terminated, as you can see on this particular graph here, because of the serious concerns that these activities were no longer contributing significantly to the quality of education.

And 1982 was, I think, a year of review. Considerable discussions had taken place between the administration and Congress at that particular point in time, and that led to a rebuilding of the precollege activities in which NSF's role was to provide leadership and serve as a catalyst in developing course materials, innovative teacher activities, and support for out-of-school activities.

The precollege funding increase was, therefore, dramatic, as you can see on this particular chart here. In fact, if you look at it in 1986, the majority of the dollars are allocated to this particular effort.

In addition to that, the fellowships are being continued, obviously, at a slightly increasing kind of a rate, and the other support is what you see.

So the point that I want to make about this particular area—it has undergone a large number of changes; it had to undergo a rebuilding; and what you are seeing as a consequence of that one is a change in aspect of what this program is all about; namely, a heavy concentration on precollege education, which was not the case before, on the fellowships, obviously, and some of the other support, which is primarily instrumentation—instrumentation for this particular area.

These are complex issues; I am sure we are going to get into them in a little while in your question and answer period.

Let me make one point, however, still on it. For all of these reasons—finding the right direction, rebuilding this particular Directorate, changing the emphasis—we have deferred $31 million from 1985 into 1986 because we were not convinced that we could spend the money in a reasonable and responsive kind of way in 1985. And I think we can discuss this question later on in more detail.

The last point that I want to make is essentially, what is the role that NSF plays in the Federal support of R&D. And if you look at the total NSF share of the total R&D we are a small number, about 3 percent. If you look at the NSF share of the total basic research that we are supplying, it's about 17 percent; and if you look at the NSF share of the basic research in colleges and universities, it's a significant 27 percent. That really shows where our focus is and what the role and the mission of the National Science Foundation is all about. The numbers in parentheses that you see, the 7 percent—it's 7 percent in all of these 3 areas—is essentially the increase between 1985 and 1986, between the NSF share and the total R&D of the Federal Government.

And this, Mr. Chairman, concludes my discussion and I'd be glad to answer questions.

[The prepared statement of Mr. Bloch follows:]

National
Science
Foundation

STATEMENT OF
MR. ERICH BLOCH
DIRECTOR, NATIONAL SCIENCE FOUNDATION
BEFORE THE
SUBCOMMITTEE ON SCIENCE AND TECHNOLOGY
HOUSE OF REPRESENTATIVES
FEBRUARY 21, 1985

MR. CHAIRMAN AND MEMBERS OF THE SUBCOMMITTEE:

IT IS A PLEASURE TO BE HERE THIS MORNING TO TALK ABOUT THE NATIONAL SCIENCE FOUNDATION. MY FIRST FIVE MONTHS AS DIRECTOR OF THE FOUNDATION HAVE BEEN EXCITING, AND I LOOK FORWARD TO DISCUSSING OUR PROPOSED PROGRAMS FOR 1986 IN THIS HEARING.

THE NATIONAL SCIENCE FOUNDATION MEETS ITS RESPONSIBILITY FOR THE HEALTH OF THE SCIENTIFIC ENTERPRISE BY SUPPORTING THE MOST PROMISING FUNDAMENTAL, LONG-TERM RESEARCH BY THE BEST MINDS IN ALL FIELDS OF SCIENCE AND ENGINEERING.

THE PRINCIPAL PRODUCTS ARE:

o NEW KNOWLEDGE AND DISCOVERIES FROM THE CUTTING EDGE OF RESEARCH, AND

o THE EDUCATION AND TRAINING OF THE WORLD'S MOST TALENTED AND CREATIVE SCIENTISTS AND ENGINEERS.

GAINING A NEW AND DEEPER UNDERSTANDING OF NATURE, AND REPLENISHING OUR SUPPLY OF SCIENTISTS AND ENGINEERS ARE ESSENTIAL IF WE ARE TO IMPROVE THE NATION'S INDUSTRIAL COMPETITIVENESS, DEFENSE, ECONOMY, HEALTH AND GENERAL WELL-BEING OF OUR CITIZENS.

IN MY DISCUSSION TODAY I WILL FOCUS ON:

o THE CHALLENGES FACING THE SCIENTIFIC COMMUNITY, AND THE IMPLICATIONS THESE HAVE FOR THE SOCIAL AND ECONOMIC FABRIC OF THE U.S.

o THE FEDERAL ROLE, AND IN PARTICULAR, THE RESPONSIBILITIES OF THE NATIONAL SCIENCE FOUNDATION FOR SCIENTIFIC AND ENGINEERING RESEARCH.

- The strategy the Foundation pursues to meet these responsibilities, and carry out this Administration's strong policy for basic research.

Lastly, I will highlight the proposed budget for 1986, and discuss several activities in greater detail.

First, It is my pleasure to introduce to you Dr. Roland Schmitt, Chairman of the National Science Board and Vice President of Corporate Research and Development for the General Electric Corporation. Dr. Schmitt will briefly describe to you some of the priorities and issues that are of concern to the Board.

Dr. Schmitt

Challenges for Research

As I see it, there are three major challenges facing us:

- The increasing complexity of scientific and engineering research
- resource needs and shortages
- world competition in key research areas.

Complexity and change are not new to science and engineering; but the complexity in research is greater and the rate of change is increasing in every aspect of science and engineering research compared to the past. We see this not only in the problems we have identified for study, but in the research process as well.

Analytical techniques and instrumentation are increasing in power, sophistication and cost. Yet, we must utilize these techniques if we are to explore, observe, and understand phenomena characterized by smaller scales, shorter times, and weaker signal

STRENGTHS. ELECTRON MICROSCOPES, RADIO TELESCOPES AND SUPERCOMPUTERS HAVE HIGH PRICE TAGS, BUT ARE ABSOLUTELY ESSENTIAL IF WE ARE TO CONTINUE TO EXPAND OUR BASE OF SCIENTIFIC KNOWLEDGE.

WE ARE ALSO BEGINNING TO EXPERIENCE BREAKDOWNS OF THE BARRIERS BETWEEN TRADITIONAL DISCIPLINES AND FIELDS. WE CAN SEE THIS CLEARLY IN SUCH AREAS AS BIOTECHNOLOGY, MATERIALS SCIENCE, ENGINEERING AND COMPUTER SCIENCE. AT THE INTERFACE OF DISCIPLINES AND FIELDS IS WHERE MAJOR RESEARCH PROGRESS OFTEN IS MADE AND NEW TECHNOLOGIES EMERGE.

THE COMPLEXITY AND INCREASE IN THE RATE OF CHANGE DEMAND CONSTANT COMMUNICATION, AND A NEED TO BRING TOGETHER SCIENTISTS FROM TRADITIONALLY DISTANT DISCIPLINES TO SHARE AND EXCHANGE KNOWLEDGE, SKILLS, RESOURCES, AND EQUIPMENT.

THIS CHANGING ENVIRONMENT WILL, IF HARNESSED PROPERLY, HAVE A POSITIVE EFFECT ON SCIENCE AND ENGINEERING KNOWLEDGE AND RESEARCH

- BASIC RESEARCH RESULTS WILL BE SHARED, CROSS-STIMULATING AND ACCELERATING NEW RESEARCH OPPORTUNITIES.

- NEW INSTITUTIONAL RELATIONSHIPS WILL DEVELOP, FOSTERING MORE COOPERATION--AND PARTICIPATION--AMONG INDUSTRY, ACADEMIA, AND GOVERNMENT.

THE COMPLEXITY OF SCIENTIFIC AND ENGINEERING RESEARCH OFFERS UNLIMITED OPPORTUNITIES FOR EXPANDING OUR KNOWLEDGE AND CONTRIBUTING ULTIMATELY TO MAJOR IMPROVEMENTS IN OUR QUALITY OF LIFE. THE MORE WE KNOW, THE MORE WE WANT TO KNOW. AND AS WE LEARN, WE FIND MORE THINGS WE MUST LEARN ABOUT.

BUT, CLEARLY, THERE ARE CONSTRAINTS, AND ONE THAT WE ALL FACE -- AS INDIVIDUALS AND PUBLIC OFFICIALS -- IS RESOURCE AVAILABILITY.

THIS SAME CONSTRAINT EXISTS IN SCIENCE AND ENGINEERING RESEARCH. THE NATION NEEDS AN ADEQUATE SUPPLY OF PROFESSIONALS FOR INDUSTRY, GOVERNMENT, AND ACADEMIA, ESPECIALLY IN THE EMERGING SCIENCE AREAS.

THIS REQUIRES THAT WE NOT ONLY MAINTAIN A STIMULATING YET COMPETITIVE ENVIRONMENT FOR EXISTING SCIENTISTS AND ENGINEERS, BUT ALSO AN ENVIRONMENT THAT ENCOURAGES OUR YOUNG STUDENTS--THE SCIENTISTS AND ENGINEERS OF TOMORROW -- TO SEEK CAREERS IN ALL FIELDS OF SCIENCE AND ENGINEERING.

FINANCIAL RESOURCES ARE ALSO EXTREMELY IMPORTANT, ESPECIALLY WITH THE NEED FOR COSTLY INSTRUMENTATION, EQUIPMENT, AND FACILITIES NECESSARY TO CARRY OUT BASIC RESEARCH. BUT THEY MUST BE EFFICIENTLY AND EFFECTIVELY USED; WE CANNOT AFFORD THE LUXURY OF "THROWING DOLLARS AT RESEARCH." ON THE OTHER HAND, WE CANNOT BYPASS EXPENSIVE RESEARCH SIMPLY BECAUSE IT IS EXPENSIVE. WHAT WE MUST DO IS MAKE CHOICES, AND WE DO THIS BY ASSURING EXCELLENCE, SETTING PRIORITIES, AND FOCUSING ON IMPORTANT LINES OF INQUIRY.

THE THIRD CHALLENGE, WORLD COMPETITION, COMES IN MANY FORMS. WE, OF COURSE, ARE MOST FAMILIAR WITH ECONOMIC COMPETITION, BUT THERE IS COMPETITION IN RESEARCH ALSO. THIS NATION HAS ALWAYS HAD A LEADERSHIP ROLE IN TECHNOLOGY, DEVELOPED THROUGH THE HEALTH AND STRENGTH OF OUR RESEARCH BASE. THIS HAS ENABLED US TO MAINTAIN AND INCREASE PRODUCTIVITY.

BUT, THERE IS AN INCREASED REALIZATION BY INDUSTRIALIZED NATIONS THAT SCIENCE AND TECHNOLOGY ARE AT THE HEART OF ECONOMIC PROGRESS. AS A RESULT, WE ARE BEGINNING TO SEE RESEARCH EFFORTS EMPHASIZED BY FOREIGN TRADING PARTNERS, CHALLENGING THE U.S. LEADERSHIP ROLE IN EMERGING FIELDS SUCH AS SUPERCOMPUTERS AND BIOTECHNOLOGY.

EMERGING NATIONS ARE EMULATING THE SUCCESS OF INDUSTRIALIZED NATIONS BY CONVERTING RESEARCH RESULTS INTO MARKETABLE TECHNOLOGY.

WE MUST CONTINUE TO BE COMPETITIVE BY KEEPING OUR RESEARCH AND TECHNOLOGY ON THE CUTTING EDGE, AND BY BEING FIRST IN TRANSLATING RESEARCH RESULTS INTO PRODUCTS IN THE MARKETPLACE. CLEARLY, WE MUST WORK HARD TO MAINTAIN OUR PREEMINENCE IN SCIENCE AND ENGINEERING RESEARCH AND TECHNOLOGY; WE CANNOT TAKE IT FOR GRANTED.

THE THREE CHALLENGES -- COMPLEXITY, RESOURCE AVAILABILITY AND WORLD COMPETITION -- MUST BE MET SUCCESSFULLY IF WE ARE TO MAINTAIN A STRONG, GROWING INDUSTRIAL BASE FOR OUR NATION, AND CONTINUED IMPROVEMENTS IN THE QUALITY OF LIFE.

TODAY, THERE IS RESOLVE TO MEET THESE CHALLENGES HEAD ON. THERE IS GREATER PUBLIC AWARENESS THAT BASIC SCIENTIFIC AND ENGINEERING RESEARCH IS IMPORTANT TO MAINTAINING ECONOMIC GROWTH AND IMPROVING THE QUALITY OF LIFE, AND A MORE COOPERATIVE ENVIRONMENT AMONG INDUSTRY, ACADEMIA AND GOVERNMENT, READY TO SHARE IN THE RESPONSIBILITY TO MAINTAIN SCIENTIFIC LEADERSHIP.

2. ROLE OF GOVERNMENT AND THE NSF

IF ADVANCING SCIENCE AND TECHNOLOGY IS AN IMPORTANT PART OF THE ANSWER, THEN WE MUST ASK: WHOSE RESPONSIBILITY IS IT TO DO THE RESEARCH? TRAIN PEOPLE? PROVIDE FUNDING?

SOME YEARS AGO, THE RESPONSIBILITY MIGHT WELL HAVE BEEN PLACED SQUARELY ON THE SHOULDERS OF THE FEDERAL GOVERNMENT. BUT THERE IS A GROWING REALIZATION THAT MANY PARTNERS -- INCLUDING THE FEDERAL GOVERNMENT, INDUSTRY, STATE AND LOCAL GOVERNMENTS, AND UNIVERSITIES -- HAVE A STAKE IN THE OUTCOME, AND THAT EACH HAS A ROLE TO PLAY AND MUST BE AN ACTIVE PARTICIPANT IF WE ARE TO REALIZE MAXIMUM BENEFITS.

LET ME BRIEFLY DESCRIBE WHAT PART OTHER MAJOR PLAYERS HAVE IN SCIENTIFIC AND ENGINEERING RESEARCH.

o UNIVERSITIES HAVE A DUAL ROLE: TO EDUCATE AND THROUGH RESEARCH, CONTRIBUTE TO THE KNOWLEDGE POOL. THESE TWO ROLES ARE NOT SEPARATE. RESEARCH IS AN EDUCATIONAL TOOL AND IT TAKES EDUCATED PEOPLE TO DO RESEARCH.

o INDUSTRY HAS A STAKE IN BASIC RESEARCH BECAUSE IT PROVIDES THE BASIS FOR NEW DEVELOPMENTS AND INNOVATION, AND, ULTIMATELY, NEW PRODUCTS AND SERVICES.

o STATE AND LOCAL GOVERNMENTS BEAR RESPONSIBILITY FOR EDUCATION AND ECONOMIC DEVELOPMENT WITHIN THEIR GEOGRAPHIC REGIONS. THEY MUST ENSURE THAT THEIR EDUCATION PROGRAMS AND FACILITIES PROVIDE WELL-EDUCATED AND TRAINED GRADUATES THAT WILL ATTRACT AND PROMOTE ECONOMIC DEVELOPMENT AND EXPANSION.

LET ME NOW TURN TO OUR ROLE IN SUPPORTING BASIC RESEARCH. THE FEDERAL GOVERNMENT PROVIDES ABOUT 67% OF BASIC RESEARCH SUPPORT, RESEARCH WHICH ULTIMATELY BENEFITS THE ENTIRE NATION IN THE LONG TERM ACROSS A BROAD AND VARIED SPECTRUM OF PRODUCTS AND SERVICES THAT MAINTAIN AND IMPROVE THE QUALITY OF LIFE.

THIS NATIONAL PERSPECTIVE ALLOWS US TO:

o NURTURE PROMISING NEW AND EMERGING SCIENCE AND ENGINEERING RESEARCH WITHOUT LOOKING EXCLUSIVELY FOR IMMEDIATE AND HIGH RETURNS. OUR PAYBACK WILL COME IN THE KNOWLEDGE THAT OUR INVESTMENTS IN BASIC RESEARCH TODAY WILL IMPROVE LIFE FOR OUR CHILDREN AND GRANDCHILDREN.

o DEVELOP AND MAINTAIN MAJOR BASIC RESEARCH FACILITIES THAT SERVE THE COMPLEX, MULTIDISCIPLINARY REQUIREMENTS OF TODAY'S RESEARCH. EXPENSIVE EQUIPMENT, ACCELERATORS, SHIPS, TELESCOPES, AND SUPERCOMPUTERS -- MUST BE SHARED IF THEY ARE TO BE JUSTIFIED AND PROPERLY UTILIZED.

- O DRAW ON THE BEST SCIENTIFIC AND ENGINEERING TALENT AVAILABLE.

3. NSF GOALS AND STRATEGY

NOW WHAT ABOUT THE GOALS AND STRATEGIES OF THE NATIONAL SCIENCE FOUNDATION? WHAT CAN WE DO TO MEET THESE CHALLENGES, AND CARRY OUT THIS ADMINISTRATION'S AND THE CONGRESS' STRONG POLICY AND FUNDING SUPPORT FOR BASIC SCIENTIFIC AND ENGINEERING RESEARCH?

THE FIRST GOAL IS EXCELLENCE. IN SCIENCE AND ENGINEERING RESEARCH, AS IN ANY CREATIVE ENDEAVOR, THE BEST IS VASTLY MORE VALUABLE THAN THE MERELY GOOD.

- O EXTERNALLY, IN OUR GRANTS AND CONTRACTS FOR RESEARCH, EXCELLENCE MEANS MERIT-BASED PEER REVIEW. IT IS STILL THE BEST WAY TO ENSURE HIGH QUALITY AND THE BEST RETURN FOR THE NATION'S INVESTMENT.

- O INTERNALLY, WITHIN THE FOUNDATION, WE WILL CONCENTRATE ON GOOD MANAGEMENT, USING AUTOMATION WHERE POSSIBLE TO IMPROVE OUR EFFICIENCY.

SECOND, THE FOUNDATION MUST BE A CATALYST FOR CHANGE IN THE SCIENTIFIC AND ENGINEERING COMMUNITY. THIS MEANS NOT ONLY PURSUING NEW RESEARCH OPPORTUNITIES, BUT ALSO ENCOURAGING NEW WAYS TO CARRY OUT SUCH RESEARCH.

- O APPLYING INTERDISCIPLINARY APPROACHES TO NEW AND EMERGING RESEARCH POSSIBILITIES.

- O DEVELOPING NEW RELATIONSHIPS BETWEEN GOVERNMENT AND PRIVATE INSTITUTIONS, AND BETWEEN INDUSTRY AND UNIVERSITIES.

- O INCREASING COMMUNICATION, STIMULATING THE SHARING OF EXPENSIVE EQUIPMENT, FACILITIES, AND KNOWLEDGE.

While we may encourage science and engineering research to move in new directions in a concerted way, we must and will continue to support individual research projects carried out by a principal investigator and a few students. It is a simple yet most effective strategy.

The key is to balance this with large-scale cooperative efforts. There is ample opportunity and need for both: It is not a question of one approach or the other.

Third, NSF must try to improve the health of the science and engineering infrastructure. Instrumentation, special facilities integral to research and human resources must be the best if we are to revitalize the academic research base. We will continue to support new and enhanced instrumentation and access to it.

Fourth, we must continue to help attract, educate, and train students for science and engineering. We are doing this through:

o Fellowships open to all qualified applicants;

o Special programs directed at minorities, women, and the handicapped;

o Programs designed to attract and retain faculty in disciplines where faculty shortages impede basic research progress;

o Programs keyed to the improvement of precollege science and mathematics education; and

o Increased support to undergraduate and graduate students through research projects.

FINALLY, WE WILL CONTINUE TO LEVERAGE GOVERNMENT FUNDS WITH PRIVATE SECTOR, STATE AND LOCAL GOVERNMENT, AND ACADEMIC SUPPORT IN ALL AREAS WHERE COOPERATION IS A POSSIBILITY AND IN THE BEST INTERESTS OF ALL PARTICIPANTS.

TO MOVE TOWARD THESE GOALS GIVEN THE BUDGET ENVIRONMENT FOR FY 1986, THE FOUNDATION MADE DECISIONS TO MAXIMIZE THE IMPACT OF FUNDING AVAILABLE FOR ACADEMIC SCIENTIFIC AND ENGINEERING RESEARCH ACTIVITIES, BY:

o RECOGNIZING THE NEED AND THE ADMINISTRATION'S RESOLVE TO REDUCE ADMINISTRATIVE COSTS; WE ARE HOLDING DOWN NSF'S ADMINISTRATIVE COSTS WHICH ARE ALREADY LOW COMPARED TO THOSE OF SIMILAR ORGANIZATIONS.

o CURTAILING PROGRAMS THAT ARE NOT IN THE MAINSTREAM OF SCIENTIFIC AND ENGINEERING RESEARCH.

o STRETCHING OUT CONSTRUCTION AND ACQUISITION OF SEVERAL MAJOR RESEARCH PROJECTS SUCH AS THE VLBA.

o MAKING TRADE-OFFS WITH ONGOING BASE PROGRAMS IN ORDER TO PROVIDE FOR ENHANCEMENTS IN SEVERAL KEY AREAS WHERE RESEARCH IS ESSENTIAL TO THE NATION'S PURSUIT OF SCIENTIFIC AND TECHNOLOGICAL EXCELLENCE AND TO THE TRAINING THE NEXT GENERATION OF SCIENTISTS AND ENGINEERS.

4. NSF BUDGET REQUEST

NSF'S FY 1986 BUDGET REQUEST CONTINUES THE MOMENTUM ESTABLISHED BY THIS ADMINISTRATION, AND SUPPORTED BY CONGRESS, TO KEEP U.S. SCIENTIFIC AND ENGINEERING RESEARCH AT THE LEADING EDGE.

THE FOUNDATION'S FY 1986 BUDGET REQUEST TOTALS $1,569.4 MILLION OR 4.4% ABOVE THE FY 1985 CURRENT PLAN OF $1,502.7 MILLION. IT INCLUDES:

- o $1,397.8 MILLION FOR RESEARCH AND RELATED ACTIVITIES, AN INCREASE OF 7.4%.
- o $120.1 MILLION FOR THE U.S. ANTARCTIC PROGRAM, UP 8.4%.
- o $50.5 MILLION OF NEW OBLIGATIONAL AUTHORITY FOR SCIENCE AND ENGINEERING EDUCATION WHICH, COMBINED WITH A DEFERRAL OF $31.5 MILLION FROM FY 1985, PROVIDES TOTAL RESOURCES OF $82.0 MILLION, THE SAME LEVEL AS 1985.

THIS BUDGET REQUEST, IF APPROVED BY CONGRESS:

- o MAINTAINS SUPPORT AT CURRENT LEVELS FOR RESEARCH OF PROVEN QUALITY ACROSS ALL DISCIPLINES.
- o INCREASES SUPPORT FOR RESEARCH RELATED TO U.S. ECONOMIC COMPETITIVENESS SUCH AS ENGINEERING RESEARCH CENTERS, AND BIOTECHNOLOGY.
- o INCREASES RESEARCH PROGRAMS THAT PROVIDE THE BASIS FOR ADVANCES IN SCIENCE AND TECHNOLOGY, INCLUDING THE SPECIFIC FACILITIES THAT ARE AN INTEGRAL PART OF THE PROPOSED RESEARCH. SOME FACILITY ACTIVITIES, HOWEVER, WHILE CONTINUING TO BE FUNDED WILL CONTINUE AT A SOMEWHAT SLOWER PACE THAN ORIGINALLY PLANNED.
- o FOCUSES PRESIDENTIAL YOUNG INVESTIGATOR AWARDS ON FACULTY YOUNGER THAN PREVIOUS RECIPIENTS AND PROVIDES AN ADDITIONAL $6.0 MILLION TO SUPPORT 100 NEW AWARDS IN 1986, BRINGING THE TOTAL TO 500.

THESE ARE SOME OF THE HIGHLIGHTS OF OUR 1986 REQUEST. THERE ARE SEVERAL ACTIVITIES THAT I WOULD LIKE TO DISCUSS IN GREATER DETAIL.

SCIENCE AND ENGINEERING EDUCATION (SEE)

THE FY 1985 PROGRAM TOTAL FOR SEE IS $82.0 MILLION. THIS TOTAL INCLUDES AN FY 1986 REQUEST FOR NEW OBLIGATIONAL AUTHORITY OF $50.5 MILLION AND DEFERRAL OF $31.5 MILLION FROM FY 1985. WITH THE DEFERRAL, THE FY 1986 PROGRAM TOTAL REMAINS THE SAME AS THE FY 1985 LEVEL.

DEFERRAL

DESPITE OUR INITIAL OPTIMISM AND BEST EFFORTS THERE ARE SEVERAL FACTORS THAT MAKE IT UNLIKELY THAT WE WILL REACH OUR EARLIER GOAL OF FULL EXPENDITURE OF ALL SEE FUNDS (I.E., $113 MILLION) IN FY 1985, ESPECIALLY IN THE PRECOLLEGE PROGRAMS. WE WILL MEET OUR PREVIOUS GOALS IN THE GRADUATE FELLOWSHIPS AND COLLEGE SCIENCE INSTRUMENTATION PROGRAMS.

FIRST OF ALL, I'D LIKE TO POINT OUT THAT THE FUNDING LEVELS FOR PRECOLLEGE ACTIVITIES FROM FY 1975 TO FY 1983 WERE LESS THAN $20 MILLION PER YEAR. BECAUSE IT TAKES TIME FOR GOOD RESEARCH TEAMS AND PARTNERSHIPS TO FORM AND TO BECOME PRODUCTIVE, WE DO NOT BELIEVE IT IS WISE TO SPEND THE ORIGINALLY APPROPRIATED AMOUNT IN FY 1985. BOTH THE MATERIALS DEVELOPMENT, AND TEACHER IMPROVEMENT AND INFORMAL SCIENCE EDUCATION PROGRAM ARE EXTREMELY COMPLEX AND SENSITIVE. WE NEED TO MOVE FORWARD, BUT WITH CAUTION, BEING DOUBLY SURE WE ARE ONLY SUPPORTING ONLY THE VERY BEST THAT FORM A PATTERN OR NETWORK.

AS A RESULT, THE GOAL OF OBLIGATING OVER $80 MILLION IN THE PRECOLLEGE PROGRAMS IN FY 1985 NOW APPEARS TO BE UNREALISTIC.

BACKGROUND

THE MAIN ELEMENTS OF THE FOUNDATION'S SCIENCE AND ENGINEERING EDUCATION ACTIVITIES ARE THE GRADUATE FELLOWSHIPS PROGRAM, THE PRECOLLEGE SCIENCE AND MATHEMATICS EDUCATION PROGRAMS AND THE COLLEGE SCIENCE INSTRUMENTATION PROGRAM.

OVER THE LAST DECADE, WE HAVE MAINTAINED A STRONG FELLOWSHIPS PROGRAM. WITH THE INCREASE IN 1985 IN THE FELLOWSHIPS STIPENDS TO $11.1K AND $6.0K FOR THE ASSOCIATED COST OF EDUCATION ALLOWANCE TO THE FELLOW'S CHOSEN INSTITUTION, WE BELIEVE THAT THIS PROGRAM IS VERY ATTRACTIVE TO THE NATION'S MOST TALENTED GRADUATE STUDENTS AND THEIR INSTITUTIONS.

THE PRECOLLEGE AND COLLEGE LEVEL ACTIVITIES THAT WERE IN PLACE PRIOR TO FY 1981 WERE PHASED OUT BY THIS ADMINISTRATION IN FY 1982 BECAUSE OF SERIOUS CONCERNS THAT THESE ACTIVITIES WERE NO LONGER CONTRIBUTING SIGNIFICANTLY TO THE QUALITY OF U.S. SCIENCE AND ENGINEERING EDUCATION. PART OF THE PROBLEM WAS THE NUMBER OF UNDER FUNDED, FRAGMENTED PROGRAMS, AND THERE WAS ALSO CONCERN THAT THE FOUNDATION'S ACTIVITIES WERE NOT ADEQUATELY COUPLED TO THE LARGE INVESTMENTS IN EDUCATION BEING MADE BY STATE AND LOCAL GOVERNMENTS.

WITH THE NATIONAL FOCUS ON THE DECLINING QUALITY OF PRECOLLEGE EDUCATION IN THE COUNTRY, SEVERAL STUDIES AND CONSIDERABLE DISCUSSION BETWEEN THE ADMINISTRATION AND THE CONGRESS LED TO A REBUILDING OF THE FOUNDATION'S PRECOLLEGE SCIENCE AND ENGINEERING EDUCATION ACTIVITIES STARTING IN FY 1983. THE NEW ROLE OF THE FOUNDATION IS TO PROVIDE LEADERSHIP AND TO SERVE AS A CATALYST IN THE DEVELOPMENT OF COURSE MATERIALS AND INNOVATIVE TEACHER ENHANCEMENT ACTIVITIES, BUT NOT BE RESPONSIBLE OR TAKE AWAY FROM OTHER FEDERAL, STATE, AND LOCAL ACTIVITIES OR RESPONSIBILITIES.

IN THE PAST YEAR WE HAVE MADE CONSIDERABLE PROGRESS IN CONDUCTING LEADERSHIP ACTIVITIES TO INFORM AND/OR STIMULATE OTHER SECTORS AND IN SUPPORTING HIGH LEVERAGE ACTIVITIES THAT WILL SERVE AS PROTOTYPES AND MODELS OF EXCELLENCE FOR THE NATION. A MAJOR OBJECTIVE IS TO ENCOURAGE PARTNERSHIPS AND COOPERATION AMONG CONCERNED GROUPS SUCH AS EDUCATIONAL AGENCIES, ACADEMIA, AND BUSINESS. THE CONSORTIUM FOR MATHEMATICS AND ITS APPLICATIONS (COMAP) IS AN EXCELLENT EXAMPLE OF AN NSF-SUPPORTED ACTIVITY THAT IS DEVELOPING AND DISTRIBUTING BOTH IN-SERVICE AND PRE-SERVICE

TEACHER EDUCATION MATERIALS THAT EMPHASIZE THE TEACHING OF MATHEMATICS THROUGH ITS EVERYDAY APPLICATIONS. THE COMAP MATERIALS ARE DISTRIBUTED THROUGH A NATIONAL NETWORK OF MATHEMATICS PROFESSORS AND TEACHERS. MOREOVER, COMAP HAS INDUSTRIAL SPONSORS FOR DEVELOPING MODELS IN MATHEMATICS AND INSTRUCTIONAL TECHNOLOGY.

IN FY 1985, WE STARTED THE COLLEGE SCIENCE INSTRUMENTATION PROGRAM AT THE $5 MILLION LEVEL APPROPRIATED BY THE CONGRESS. WE ARE PROPOSING TO CONTINUE THIS ACTIVITY AT THE SAME LEVEL IN FY 1986. THIS PROGRAM COMPLEMENTS THE FUNDING OF INSTRUMENTATION FOR UNIVERSITY LABORATORIES THAT IS PROVIDED THROUGH RESEARCH PROJECT SUPPORT.

SINCE FY 1982, THE FOUNDATION HAS BEEN ADDRESSING THE EDUCATION AND TRAINING NEEDS AT THE GRADUATE AND UNDERGRADUATE LEVELS BY FOCUSING ON THE FOUNDATION'S ORIGINAL LEGISLATIVE MANDATE TO COUPLE RESEARCH WITH EDUCATION. CURRENTLY, OVER 11,000 GRADUATE STUDENTS AND 3,000 UNDERGRADUATES ARE PARTICIPATING IN FOUNDATION-SUPPORTED RESEARCH ACTIVITIES.

IT IS IMPORTANT TO NOTE THAT MOST OF THE SEE FUNDING FROM FY 1976 TO FY 1982 WAS FOR COLLEGE-LEVEL ACTIVITIES, WHICH ARE NOT CURRENTLY A MAJOR PART OF THIS DIRECTORATE'S STRATEGY.

IN ADDITION, WE HAVE AN EXCELLENT PROGRAM OF FUNDAMENTAL RESEARCH RELATED TO TEACHING AND LEARNING THAT IS BEING SUPPORTED AT THE LEVEL OF $5 MILLION IN THE BIOLOGICAL, BEHAVIORAL, AND SOCIAL SCIENCES DIRECTORATE. WE ARE PROPOSING TO CONTINUE THESE IMPORTANT RESEARCH ACTIVITIES AT THE SAME LEVEL IN FY 1986. IN FY 1984, SUPPORT FOR THESE ACTIVITIES WAS PROVIDED THROUGH THE SEE APPROPRIATION.

I AM PERSONALLY COMMITTED TO HAVING A QUALITY SEE PROGRAM. WE HAVE MADE A MAXIMUM EFFORT TO RECRUIT A QUALIFIED STAFF AND HAVE MADE A NUMBER OF TEMPORARY SHIFTS WITHIN THE FOUNDATION TO ACCELERATE AND ROUND OUT THE SEE STAFFING IN FY 1985.

LAST YEAR AT THIS TIME WE ONLY HAD 39 PEOPLE ON BOARD. TODAY WE HAVE 55. ALTHOUGH WE STILL NEED ADDITIONAL PROGRAM DIRECTORS IN THE MATERIALS DEVELOPMENT AREA TO HAVE THE NUMBER AND MIX NEEDED FOR THE LONG TERM, THERE IS NO DOUBT THAT WE HAVE SUFFICIENT STAFF TO PROCESS THE PROPOSALS THAT WE ARE EXPECTING IN FY 1985 AND FY 1986.

FINALLY, I BELIEVE THAT OUR CURRENT EMPHASIS ON THE MIDDLE AND ELEMENTARY SCHOOL LEVELS IS WHERE THE GREATEST NEED IS BECAUSE THESE YEARS ARE CRITICAL TO THE CHOICES THAT WILL BE AVAILABLE TO STUDENTS IN THE FUTURE. WITH RESPECT TO THE BUDGET LEVELS IN FY 1985 AND FY 1986, I BELIEVE THE PROPOSED AMOUNTS ARE WHAT IS NEEDED TO FUND THE PROPOSALS THAT HAVE A REASONABLE CHANCE OF MAKING AN IMPORTANT CONTRIBUTION.

RELATIONSHIP TO THE EDUCATION FOR ECONOMIC SECURITY ACT (P.L. 98-377)

THE FOUNDATION STRONGLY SUPPORTS THE STATED PURPOSE AND THE EVIDENT INTENT OF THE ACT. WE HAVE WORKED HARD IN THE PAST YEAR TO ESTABLISH A STRONG SCIENCE AND ENGINEERING EDUCATION PROGRAM AND TO BUILD THE STAFF NECESSARY TO ADMINISTER IT. IN PARTICULAR, THE FOUNDATION AGREES WITH THE PHILOSOPHY WHICH IS EVIDENT IN MANY SPECIFIC PROVISIONS OF THE ACT:

- THE EMPHASIS ON PARTNERSHIPS BETWEEN UNIVERSITIES, LOCAL AND STATE GOVERNMENTS, INDUSTRY, AND THE FEDERAL GOVERNMENT IS IMPORTANT. I HAVE SPOKEN FREQUENTLY ON THIS NEED IN OTHER CONTEXTS. IT IS EMBODIED IN OUR PROGRAM GUIDELINES FOR SEE AND IN OTHER PROGRAMS SUCH AS PRESIDENTIAL YOUNG INVESTIGATORS AND ENGINEERING RESEARCH CENTERS.

- THE VALUE OF WIDESPREAD DISTRIBUTION HAS LONG BEEN RECOGNIZED IN THE FOUNDATION'S SEE PROGRAMS, AND REMAINS AN IMPORTANT CONSIDERATION IN AWARDING NSF FUNDS.

- THE STRESS ON IMPROVING COOPERATION BETWEEN DEPARTMENTS OF MATHEMATICS AND SCIENCE AND DEPARTMENTS OF EDUCATION IS ANOTHER POINT OF AGREEMENT.

- THE NEED FOR COOPERATION AND CONSULTATION BETWEEN UNIVERSITIES AND STATE AND LOCAL EDUCATION AGENCIES IS ALSO IMPORTANT, AND IS STRONGLY ENCOURAGED BY OUR PROGRAM GUIDELINES.

- THE EMPHASIS ON PROVIDING SERVICES TO SEGMENTS OF THE POPULATION WHICH ARE UNDERREPRESENTED IN SCIENCE AND ENGINEERING IS A LONG-STANDING PRIORITY OF THE FOUNDATION WHICH IS EMBODIED IN MANY PROGRAMS.

HAVING NOTED THESE IMPORTANT AREAS OF AGREEMENT, HOWEVER, I MUST POINT OUT THAT THIS AUTHORIZATION WAS NOT ACCOMPANIED BY THE APPROPRIATION NEEDED TO MAKE IT EFFECTIVE. MANY OF THE PROGRAMS IT AUTHORIZES ARE CONSISTENT WITH THE PRESIDENT'S PROGRAM FOR FY 1985 AND WITH THE NSF ACT. WE ARE IMPLEMENTING SUCH PROGRAMS IN FY 1985 TO THE EXTENT THAT APPROPRIATIONS, PROPOSALS, AND STAFF RESOURCES ALLOW.

SPECIFIC REQUIREMENTS OF THE ACT ARE NOT CONSISTENT WITH EFFECTIVE EXECUTION OF THE FY 1985 PROGRAM. MAJOR EXAMPLES ARE:

- THE REQUIREMENT FOR JOINT SUBMISSION OF PROPOSALS CONTAINED IN TITLE I AND THE REQUIREMENT FOR STATE APPROVAL CONTAINED IN TITLE III WOULD, IF IMPLEMENTED, REQUIRE US TO RULE INELIGIBLE VIRTUALLY ALL PROPOSALS WHICH HAVE BEEN RECEIVED TO DATE. ANY ATTEMPT TO HAVE THESE PROPOSALS RESUBMITTED WOULD MAKE IMPOSSIBLE THE ORDERLY COMMITMENT OF FY 1985 FUNDS. THE FOUNDATION QUESTIONS THE DESIRABILITY OF RIGID REQUIREMENTS OF THIS SORT, HOWEVER VALUABLE SUCH COOPERATIVE EFFORTS MAY BE.

- THE DISTRIBUTION REQUIREMENTS AND FUNDING CEILING CONTAINED IN SECTION 113 ARE TOO RIGID TO ALLOW THE FOUNDATION'S TRADITIONAL MERIT PRINCIPLES TO OPERATE SATISFACTORILY. WE WILL CONTINUE TO TREAT GEOGRAPHIC DISTRIBUTION AS AN IMPORTANT CONSIDERATION IN AWARDING SEE FUNDS.

- THE REQUIREMENT OF COST-SHARING SPECIFIED IN SECTION 306 MAY BE A DESIRABLE GOAL, BUT IS OVERLY RIGID AND NOT ATTAINABLE IN FY 1985. THOSE PROJECTS WITH COST-SHARING WHICH HAVE BEEN FUNDED TO DATE HAVE HAD COST-SHARING IN THE 10-15% RANGE. WE ARE WORKING TO INCREASE THIS FIGURE SUBSTANTIALLY, BUT WE BELIEVE THAT SEVERAL YEARS MAY BE NECESSARY TO ATTAIN THE OPTIMUM LEVEL.

BEYOND THESE ITEMS, THERE ARE A NUMBER OF OTHER SPECIFIC PROVISIONS OF THE ACT THAT WE BELIEVE ARE UNNECESSARILY RESTRICTIVE AND THAT MAY TEND TO LIMIT THE EFFECTIVENESS OF OUR SEE PROGRAMS.

BIOTECHNOLOGY

THE UNITED STATES IS CURRENTLY THE WORLD LEADER IN MOST ASPECTS OF BIOTECHNOLOGY. MAINTAINING THAT LEADERSHIP THROUGH FEDERAL, INDUSTRIAL AND ACADEMIC EFFORTS, INDIVIDUALLY AND IN PARTNERSHIP, IS IMPORTANT TO THE FUTURE HEALTH OF THIS COUNTRY IN ECONOMIC GROWTH, NATIONAL SECURITY, QUALITY OF LIFE, AND SCIENTIFIC PROGRESS.

WE CANNOT TAKE THAT LEADERSHIP ROLE FOR GRANTED; WE MUST CONTINUE TO WORK HARD TO MAINTAIN IT.

WHILE MANY FEDERAL AGENCIES - NIH, USDA, DOE, AND DOD -SUPPORT BIOTECHNOLOGY RESEARCH RELATED TO PROBLEM-ORIENTED APPLICATIONS, NSF HAS A UNIQUE ROLE TO PLAY.

WE SUPPORT A WIDE VARIETY OF BASIC RESEARCH ACTIVITIES SUCH AS FUNDAMENTAL GENETICS, CELL PHYSIOLOGY, CELL CULTURE BIOLOGY, NUCLEIC ACID CHEMISTRY AND MICROBIAL ECOLOGY WHICH ARE GENERALLY REGARDED AS BEING ESSENTIAL TO THE FURTHER ADVANCEMENT OF RESEARCH IN BIOTECHNOLOGY. THIS RESEARCH EMBRACES FUNDAMENTAL SCIENTIFIC AND ENGINEERING QUESTIONS.

NSF IS ALSO THE PRIMARY FEDERAL SUPPORTER OF BASIC RESEARCH IN SYSTEMATICS AND ECOLOGY THAT FORM THE SCIENTIFIC BASE NECESSARY TO ASSESS THE POTENTIAL ENVIRONMENTAL IMPACT OF THE VARIOUS PRODUCTS AND BYPRODUCTS OF BIOTECHNOLOGY.

THERE ARE SEVERAL AREAS WHERE EXPANDED NSF ACTIVITY IN FY 1986 COULD YIELD PROMISING RESULTS.

o ENHANCED SUPPORT OF KNOWLEDGE-LIMITED AREAS SUCH AS THE CHEMISTRY OF LIFE PROCESSES, BIOCHEMICAL ENGINEERING, PROTOPLAST CULTURE, AND ENZYME ACTIVE SITE COMPUTER MODELING.

o INCREASED SUPPORT FOR TRAINING THAT BRIDGES DISCIPLINES SUCH AS MOLECULAR BIOLOGY AND PLANT BIOLOGY OR ECOLOGY; CHEMISTRY AND BIOCHEMISTRY; AND CHEMICAL ENGINEERING AND BIOLOGY.

EDUCATION AND TRAINING

THIS COUNTRY REQUIRES A CONSTANT SUPPLY OF TALENTED YOUNG STUDENTS AND GRADUATES IF WE ARE TO MAINTAIN OUR LEADERSHIP ROLE IN SCIENTIFIC AND ENGINEERING RESEARCH.

NSF MAKES A SIGNIFICANT CONTRIBUTION TO ENSURE THIS SUPPLY OF HUMAN RESOURCES.

WE HAVE DIRECT SCIENCE AND ENGINEERING EDUCATION PROGRAMS, AND THROUGH RESEARCH GRANTS, PROVIDE OPPORTUNITIES FOR YOUNG SCIENTISTS

AND ENGINEERS NOT ONLY TO ENHANCE THEIR EDUCATION, BUT ALSO TO TRAIN WITH SENIOR RESEARCHERS AND SOPHISTICATED INSTRUMENTS.

ALL EDUCATION LEVELS ARE ADDRESSED.

OUR SCIENCE AND ENGINEERING EDUCATION (SEE) ACTIVITY PLACES SPECIAL EMPHASIS ON SCIENCE AND MATHEMATICS PROGRAMS AT THE ELEMENTARY AND JUNIOR HIGH SCHOOL LEVELS. AT THE SAME TIME, SUPPORT WILL CONTINUE FOR PROMISING PROGRAMS AT THE HIGH SCHOOL LEVEL.

IT IS EXTREMELY IMPORTANT TO NURTURE BUDDING SCIENCE INTERESTS IN YOUNG STUDENTS. ONE OF THE MOST SUCCESSFUL EDUCATIONAL SHOWS SPONSORED BY NSF FOR TELEVISION IS "3-2-1 CONTACT". THIS PUBLIC TELEVISION SERIES ABOUT SCIENCE, FOR 8 TO 12 YEARS OLDS, IS BROADCAST DAILY ON MOST OF THE 280 PUBLIC TV STATIONS, AND IS USED IN THE MORNING BY SCHOOLS. IT HAS WON A NUMBER OF AWARDS, STIMULATED MANY SCIENCE RELATED ACTIVITIES ACROSS THE U.S., AND GENERATED, WITHOUT GOVERNMENT FUNDING, APPROXIMATELY 700,000 READERS OF "3-2-1 CONTACT" MAGAZINE.

AT THE UNDERGRADUATE LEVEL, WE SUPPORT APPROXIMATELY 3,000 STUDENTS PARTICIPATING IN RESEARCH GRANTS, HELP WITH INSTRUCTIONAL EQUIPMENT NEEDS AT THE NATION'S FOUR-YEAR COLLEGES, AND FUND FACULTY RESEARCH PROJECTS AT PREDOMINANTLY UNDERGRADUATE INSTITUTIONS.

THE ENGINEERING RESEARCH CENTER INITIATIVE, FOR EXAMPLE, CALLS FOR THE INVOLVEMENT OF UNDERGRADUATES IN THE PROGRAM AT ALL CENTERS, THUS GIVING FUTURE ENGINEERS EARLY EXPOSURE TO THE RESEARCH ENTERPRISE.

SUPPORT FOR GRADUATE STUDENTS AND POSTDOCTORALS COMES IN LARGE PART FROM THEIR PARTICIPATION IN NSF-SUPPORTED RESEARCH GRANTS. IN 1986 THE NUMBER OF GRADUATE STUDENTS AND POSTDOCS SUPPORTED ON RESEARCH GRANTS IS EXPECTED TO INCREASE 4%, TO A TOTAL OF 14,387.

THE SEE ACTIVITY ALSO PROVIDES GRADUATE RESEARCH FELLOWSHIPS, WHICH WILL CONTINUE AT THE 1985 LEVEL OF $27.3 MILLION. IN 1986, NSF WILL MAKE 560 NEW AWARDS, BRINGING THE TOTAL NUMBER OF GRADUATE FELLOWS SUPPORTED UP TO APPROXIMATELY 1520.

ALSO, THE PRESIDENTIAL YOUNG INVESTIGATOR RESEARCH AWARDS, INITIATED IN FY 1984, WILL PROVIDE RESEARCH SUPPORT FOR THE NATION'S MOST PROMISING YOUNG SCIENCE AND ENGINEERING FACULTY MEMBERS. WITH MATCHING FUNDS AND PARTICIPATION FROM THE INDUSTRIAL SECTOR, THE AWARDS ARE INTENDED TO ENCOURAGE THESE YOUNG PEOPLE TO SELECT AND REMAIN IN ACADEMIC CAREERS, ENSURING THE EXCELLENCE OF THE NATION'S SCIENCE AND ENGINEERING EDUCATION, TRAINING, AND RESEARCH.

INTERNATIONAL

THE FOUNDATION'S INTERNATIONAL RESEARCH ACTIVITIES ARE BECOMING INCREASINGLY IMPORTANT TO THE OVERALL SUCCESS OF OUR SCIENTIFIC AND ENGINEERING RESEARCH EFFORTS.

BASIC SCIENTIFIC AND ENGINEERING RESEARCH DEALS WITH FUNDAMENTAL QUESTIONS OF OUR UNIVERSE, QUESTIONS THAT TRANSCEND NATIONAL BOUNDARIES. IT IS NO SMALL WONDER, THEN, THAT INTERNATIONAL COOPERATION AND COMMUNICATION ARE EXTREMELY IMPORTANT IN ADVANCING SCIENTIFIC AND ENGINEERING RESEARCH, AND OPTIMIZING ITS RESULTS.

INTERNATIONAL PARTICIPATION PROVIDES ACCESS TO SPECIAL FACILITIES, INSTRUMENTS AND EXPERTISE LOCATED ABROAD; PROVIDES ACCESS TO SITES TO OBSERVE NATURAL AND SOCIAL PHENOMENA; AND ENCOURAGES SHARING THE COSTS OF LARGE RESEARCH INSTALLATIONS. IN ADDITION, COOPERATIVE SCIENTIFIC AND ENGINEERING PROGRAMS OFTEN SERVE TO SUPPORT AND STRENGTHEN U.S. FOREIGN POLICY OBJECTIVES.

ONE OUT OF EVERY FIVE FOUNDATION GRANTS CONTAINS SOME FORM OF INTERNATIONAL ACTIVITY, RANGING FROM TRAVEL FOR MEETINGS HELD ABROAD TO MAJOR GLOBAL PROGRAMS SUCH AS THOSE IN THE ATMOSPHERIC AND OCEAN SCIENCES.

THE NSF HAS FORMAL BILATERAL AGREEMENTS FOR COOPERATIVE RESEARCH WITH SOME 30 COUNTRIES, CUTTING ACROSS A WIDE RANGE OF DISCIPLINES. WE ALSO PROVIDE SUPPORT TO THE NATIONAL ACADEMY OF SCIENCES FOR COOPERATION WITH SISTER ACADEMIES IN CHINA AND EASTERN EUROPE, AND PARTICIPATE IN SUCH ADMINISTRATION INITIATIVES AS THE U.S - INDIA SCIENCE AND TECHNOLOGY AGREEMENT.

FOR THE MOST PART, THE DISCIPLINE-ORIENTED RESEARCH DIRECTORATES PROVIDE THE MAJOR SUPPORT AND DIRECTION FOR INTERNATIONAL ACTIVITIES. THERE ARE TWO MAJOR INTERNATIONAL COOPERATIVE ACTIVITIES -- ANTARCTIC RESEARCH AND OCEAN DRILLING --THAT TOGETHER WITH SOME 700 OTHER PROJECTS PROVIDE $73.0 MILLION FOR RESEARCH WITH INTERNATIONAL IMPLICATIONS.

IT IS IMPORTANT FOR BOTH SCIENTIFIC AND ENGINEERING RESEARCH AND U.S. FOREIGN POLICY OBJECTIVES THAT THESE INTERNATIONAL RESEARCH ACTIVITIES BE CONTINUED.

COMPUTERS

MOST OF US ARE VERY AWARE OF THE IMPACT COMPUTER TECHNOLOGY HAS ON OUR LIFE. THE IMPACT OF THIS NEW TECHNOLOGY ON EDUCATION AND RESEARCH IS EVEN MORE PROFOUND.

IN FACT, THE COMPUTER AFFECTS THE RESEARCH PROCESS IN A FUNDAMENTAL WAY. MODELLING AND SIMULATION COMPLEMENT EXPERIMENTATION AND THE INSIGHTS GAINED ARE ENHANCED AND COMPRESSED IN TIME.

COMPUTERS AND COMPUTER TECHNOLOGY PROVIDE A UNIQUE CHALLENGE AND OPPORTUNITY TO NSF-SUPPORTED RESEARCH ACTIVITIES.

- AS RESEARCH TOOLS, THEY PROVIDE INCREDIBLE OPPORTUNITIES TO EXPLORE, OBSERVE, AND UNDERSTAND PHENOMENA. AS MORE AND MORE DISCIPLINES APPLY COMPUTER TECHNOLOGY TO THEIR RESEARCH EFFORTS, INVESTIGATORS ARE FINDING EXCITING NEW POSSIBILITIES TO EXPLORE, AND QUESTIONS TO ANSWER.

- As research disciplines, computational mathematics, computer systems and design, information science, and other areas help advance the state-of-the-art in computer technology.

We are engaged in four activities to advance research on computers and research using computers.

- Supercomputer facilities provide support for establishing and operating supercomputer centers, which will make available to the research community the most advanced computing equipment. Under the direction of the new Office of Advanced Scientific Computing, three temporary centers were established in 1984 to provide time on existing computers. The plan in 1985 is to have two more temporary centers and as many as three permanent facilities. In addition, a center using an experimental computer configuration will be established. A supercomputer from the NASA computer inventory, transferred to the Foundation in last year's appropriation bill, will be made available to university researchers.

- Networking provides support for establishing access between science and engineering researchers and large-scale computing facilities. It also will provide advanced communication services accessible to all members of the scientific community, which in turn promotes collaboration, resource sharing and rapid dissemination of research results.

- Local Facilities assist in the acquisition and operation of essential computing facilities at the researcher's office or laboratory. This would include work stations, minicomputers, graphics facilities, local area networks, array processors, and other computing facilities or services needed on a daily basis to carry out research.

- Research on Computers provides support for computational mathematics, computer design, information science, materials research, and other areas which help advance the state-of-the-art in computer technology.

Several other federal agencies, especially DOD, DOE, NASA, and NIH also provide support of this kind for scientists and engineers who are working on projects relevant to those agencies. But NSF is unique because it provides support for computers and computer research across a wide spectrum of disciplines.

This has very important consequences: NSF supported much of the early conceptual work in highly parallel computer architectures years before the relevance of that work to defense, energy, and other missions was recognized. Recently, many of the ideas and people supported by NSF have been picked up by the mission agencies, in programs such as the Strategic Computing Program of DARPA and the computer research support program of DOE.

A matter of particular importance to NSF is the training of graduate students in advanced computer research and engineering. The facilities that receive NSF support are used extensively by graduate students in all science and engineering fields to conduct research which, incidentally, is often related to or part of NSF-supported research projects. In addition, NSF-sponsored projects in computer research and engineering are an important source of support for graduate students providing salaries and research costs to several hundred students each year.

WOMEN, MINORITIES, AND HANDICAPPED

We are maintaining or increasing support for special programs that provide research opportunities for women, minorities, and disabled persons. At the same time, we are taking steps to tie these activities more directly to the discipline-oriented research programs. We believe that special programs will be successful only

TO THE EXTENT THAT THEY BRING SUCH RESEARCHERS INTO THE MAINSTREAM OF RESEARCH SUPPORT.

IN FACT MANY RESEARCH PROPOSALS FROM WOMEN, MINORITIES OR HANDICAPPED THAT CAN COMPETE OUTSIDE THESE SPECIAL PROGRAMS NEED TO BE MAINSTREAMED. RESEARCH OPPORTUNITIES FOR WOMEN (ROW) AND MINORITY RESEARCH INITIATION (MRI) PROPOSALS, FOR EXAMPLE, ARE HANDLED BY THE RELEVANT DISCIPLINARY PROGRAM. IN THIS WAY THE ROW AND MRI PROGRAMS SERVE AS ENTRY POINTS TO THE CORE RESEARCH PROGRAMS, WHERE SUBSEQUENT SUPPORT MUST BE SOUGHT.

WE HAVE DEVELOPED A BROCHURE FOR FACILITATION AWARDS FOR THE HANDICAPPED (FAH) DESCRIBING OPPORTUNITIES FOR PHYSICALLY DISABLED SCIENTISTS AND ENGINEERS. THIS INITIATIVE ENCOURAGES PRINCIPAL INVESTIGATORS TO INCLUDE IN THEIR BUDGETS FUNDS FOR RESEARCH-RELATED EQUIPMENT NECESSARY TO COMPENSATE FOR THEIR DISABLING CONDITION, OR THAT OF A DISABLED STUDENT ASSISTANT.

THE FOUNDATION WILL CONTINUE TO SUPPORT ABOUT 150 MINORITY GRADUATE FELLOWS IN FY 1986 AND WILL CONTINUE THE FY 1985 LEVEL OF EFFORT IN TWO IMPORTANT PROGRAMS: VISITING PROFESSORSHIPS FOR WOMEN (VPW) AND RESEARCH IMPROVEMENT IN MINORITY INSTITUTION (RIMI).

FINALLY, WE ARE CONDUCTING AN INTERNAL ASSESSMENT RELATED TO EQUAL OPPORTUNITY IN OUR WORKFORCE AND ADVISORY COMMITTEES. I HAVE ASKED THE ASSISTANT DIRECTORS TO REVIEW THE FINDINGS, OF THIS ASSESSMENT, AND TO DEVELOP PLANS TO ASSURE EQUAL OPPORTUNITY FOR ALL.

CONTINENTAL LITHOSPHERE

THE MAJOR FOCUS OF THE FOUNDATION'S EARTH SCIENCES SUBACTIVITY IN FY 1986 IS THE CONTINENTAL LITHOSPHERE, THE RELATIVELY RIGID EXTERIOR LAYER OF THE EARTH WHICH MOVES IN A SERIES OF PLATES OVER THE EARTH'S SURFACE, FORMING THE OCEANS, MOUNTAIN RANGES AND CONFIGURATION OF THE CONTINENTS AS WE KNOW THEM TODAY. THE

CONTINENTAL CRUST, GENERATED THROUGH EONS OF PLATE INTERACTIONS, CONTAINS A PARTIAL RECORD OF DEFORMATION AND VOLCANIC EVENTS BILLIONS OF YEARS OLDER THAN ASSOCIATED WITH OCEANIC LITHOSPHERE.

THE CONTINENTAL LITHOSPHERE PROGRAM SEEKS TO UNRAVEL THIS COMPLEX HISTORY. THE PROGRAM HAS DRAWN ON REPORTS OF INTERNATIONAL BODIES, THE NAS/NRC AND AD HOC PANELS INCORPORATING SEVERAL COMPLEMENTARY APPOACHES:

o SEISMIC REFLECTION PROFILING THAT PROVIDES THE HIGHEST RESOLUTION PROFILES OF THE LITHOSPHERE'S UPPER 50 TO 70 KILOMETERS.

o SEISMOGRAPH ARRAYS LINKED TO COMPUTERS THAT PROVIDE HIGH-RESOLUTION IMAGING OF CRUST AND DEEPER PARTS OF THE LITHOSPHERE, AND POSSIBLE MOVEMENTS OF THE LITHOSPHERE AND UNDERLYING MANTLE.

o GEOPHYSICAL SENSING TECHNIQUES THAT REQUIRE CALIBRATION BY DRILLING, FOR MEASUREMENTS THAT CAN BE MADE IN NO OTHER WAY.

o CORE SAMPLING TECHNIQUES FOR ISOTOPIC AND OTHER LABORATORY STUDIES.

o SATELLITE OBSERVATIONS OF CRUSTAL MOTIONS AND SUPPORT OF LABORATORY STUDIES TO AID IN INTERPRETATION OF SEISMIC DATA.

THE AIM OF THE CONTINENTAL LITHOSPHERE PROGRAM IS AN IMPROVED UNDERSTANDING OF THE EARTH'S LITHOSPHERE IN GENERAL, AND OF THE CRUST UNDERLYING NORTH AMERICA SPECIFICALLY, THAT COULD RESULT IN REVOLUTIONARY SCIENTIFIC DISCOVERIES. THESE IN TURN COULD LEAD TO BREAKTHROUGHS IN THE SEARCH FOR POSSIBLE FUTURE NEW ENERGY SOURCES AND MINERAL DEPOSITS, RESPONSIBLE METHODS OF WASTE DISPOSAL, AND ADVANCES IN PREDICTION OF EARTHQUAKES AND VOLCANIC ACTIVITY.

ADVANCES ARE ALSO EXPECTED IN THE UNDERWATER EXPLORATION OF THE LITHOSPHERE; IN PARTICULAR, THROUGH THE OCEAN DRILLING PROGRAM USING THE MODERN, NEWLY-OUTFITTED DRILLSHIP JOIDES RESOLUTION (SEDCO/BP 471) THAT RECENTLY PUT TO SEA FOR SCIENTIFIC DRILLING.

POLAR PROGRAMS

FOR SOME TIME, THE FOUNDATION HAS BEEN CLOSELY INVOLVED WITH THE UNIQUE RESEARCH OPPORTUNITIES AVAILABLE AT THE OPPOSITE ENDS OF THE WORLD. OUR FOCUS ON THESE REGIONS CONTINUES AS PROGRAMS IN THE NATURAL SCIENCES RESPOND TO BASIC RESEARCH QUESTIONS.

WHILE THE FOUNDATION PROVIDES ONLY 15 TO 20 PERCENT OF THE FEDERAL ARCTIC RESEARCH SUPPORT, WE HAVE A NEW COORDINATING ROLE AS A RESULT OF THE ARTIC RESEARCH AND POLICY ACT OF 1984. THE FOUNDATION IS RESPONSIBLE FOR THE 11-MEMBER INTERAGENCY ARCTIC RESEARCH POLICY COMMITTEE, AND IT PROVIDES ASSISTANCE TO THE INDEPENDENT, PRESIDENTIALLY-APPOINTED ARCTIC RESEARCH COMMISSION. THE NEW ACT DIRECTS THE DEVELOPMENT AND IMPLEMENTATION OF NATIONAL POLICIES AND RESEARCH PLANS AND MORE EXTENSIVE COORDINATION OF FEDERAL AGENCY PLANNING AND BUDGETING FOR ARCTIC RESEARCH.

IN ANTARCTICA, SCIENTIFIC RESEARCH CONTINUES AS THE NATION'S PRINCIPAL EXPRESSION OF POLICY AND INTEREST WITHIN THAT REGION, ALTHOUGH IN RECENT YEARS, INTERNATIONAL POLITICAL AND DIPLOMATIC GESTURES HAVE CENTERED ON MANAGEMENT OF THE ANTARCTIC AND PARTICULARLY ITS NATURAL RESOURCES.

IN THE COMING 1985-1986 AUSTRAL SUMMER, APPROXIMATELY 100 RESEARCH PROJECTS WILL BE SUPPORTED IN ASTRONOMY, UPPER ATMOSPHERE PHYSICS, METEOROLOGY, GLACIOLOGY, GEOLOGY AND GEOPHYSICS, THE OCEAN SCIENCES, AND BIOLOGY.

WE WILL REOPEN SIPLE STATION, NEAR THE BASE OF THE ANTARCTIC PENINSULA, FOR A FINAL 2 YEARS OF OPERATION IN SUPPORT OF INVESTIGATIONS OF THE IONOSPHERE AND THE MAGNETOSPHERE.

SIPLE STATION HAS BEEN EXTREMELY PRODUCTIVE SCIENTIFICALLY, AND THE LITERATURE FROM THIS WORK IS AT THE CENTER OF INTELLECTUAL CHANGE IN UPPER ATMOSPHERE PHYSICS. WE WILL CLOSE THE STATION IN 1987 SINCE IT WILL HAVE REACHED THE END OF ITS SAFE OPERATING LIFE.

OTHER IMPROVEMENTS IN ANTARCTIC OPERATIONAL SUPPORT ARE THE INTRODUCTION OF THE ICE-STRENGTHENED RESEARCH SHIP POLAR DUKE, WHICH HAS BEEN CHARTERED, THE INSTALLATION OF SATELLITE COMMUNICATIONS FOR DATA TRANSFER FROM MCMURDO, PALMER, AND SOUTH POLE TO THE UNITED STATES, AND HABITATION IMPROVEMENTS INCLUDING A NEW WATER PLANT AT MCMURDO STATION.

CONCLUSION

MR. CHAIRMAN, THIS IS A TOUGH BUDGET YEAR FOR EVERYBODY. HARD DECISIONS HAD TO BE MADE, AND IT IS SOMETIMES DIFFICULT TO FOCUS ON PROGRAMS WITH LONG TERM PAYBACKS.

THE PRESIDENT HAS MADE HIS DECISIONS, AND THE FOUNDATION HAS FARED WELL. THAT'S IMPORTANT BECAUSE THIS ADMINISTRATION CONTINUES TO BELIEVE, AS I DO, THAT BASIC SCIENTIFIC AND ENGINEERING RESEARCH IS ESSENTIAL FOR CONTINUING ECONOMIC GROWTH, MAINTAINING THE NATIONAL SECURITY, AND IMPROVING OUR QUALITY OF LIFE.

WE TAKE THIS RESPONSIBILITY VERY SERIOUSLY. WE EVALUATED OUR PROGRAMS AND PRIORITIES AND ALSO HAD TO MAKE SOME HARD DECISIONS. WE HAVE FORGED THIS PROCESS INTO A 1986 REQUEST WHICH MAINTAINS THE MOMENTUM IN NEW SCIENTIFIC AND ENGINEERING RESEARCH, BUILDS A STRONG FOUNDATION FOR SCIENCE AND ENGINEERING EDUCATION RESEARCH, AND ACHIEVES AN OPTIMAL BALANCE BETWEEN INVESTIGATOR, GROUP AWARDS, AND LARGE FACILITIES.

THIS BUDGET REQUEST ALONG WITH YOUR CONTINUED SUPPORT SIGNALS STRONG COMMITMENT TO KEEP U.S. SCIENTIFIC AND ENGINEERING RESEARCH AND TECHNOLOGY THE WORLD'S BEST.

I'LL BE HAPPY TO ANSWER ANY QUESTIONS YOU HAVE.

Mr. Walgren. Well, thank you both for that presentation.

Just on that last chart, Mr. Bloch, the increase number with respect to all the colleges and universities is also 7 percent with respect to NSF?

Mr. Bloch. It's measured by the total Federal spending in this area.

Mr. Walgren. Yes. So 7 percent of the increase is——

Mr. Bloch. It's not 7 percent in absolute numbers.

Mr. Walgren. So although we're 3 percent of the total, we're 7 percent of the increase to universities?

Mr. Bloch. Right.

Mr. Walgren. If we were able to maintain that for a number of years, we might get proper balance.

Mr. Bloch. That depends on the total pie, obviously.

Mr. Walgren. Well, let me ask you—we may be able to dispose of this one area that was recommended by Dr. Schmitt on the requirement that the Board review and approve the commitments over and above a certain limit, and the Board's desire to delegate that to the Director. I gather you're in full support of that kind of change in the law that would enable you to make the commitment of funds in that area?

Mr. Bloch. Yes, obviously I'm in support of it, but let me make a couple of comments on it. I think it's very important because, looking over the last couple of years, what the Board had to contend with and what the committees of the Board had to contend with, because of this provision of the law they never had the time to really look at the broad aspects of our total funding. What comes into the committees is really—it's by accident—namely, it's the fact that it's over a certain amount. And if you look at the total activities of the Foundation, that's a very small amount of the total activities and not necessarily the most important ones or the most critical ones, or the most controversial ones or the ones that need the most overview and the support of the Board.

Mr. Walgren. Let me understand that again. They are to review the proposals, but that is not the most important part of the NSF's functions, as you see it?

Mr. Bloch. No. They are supposed to review not the proposals, but the grants, the grant decisions. But if you just go by a particular number, if it exceeds a certain number you review it, and if you don't exceed a certain number you don't review it. What you see of the total activity of the Foundation is a very narrow kind of a picture. What the Board needs to understand and spend more time on, and wants to spend more time on—and I wanted to spend more time on—is essentially understanding what the overall program of the Foundation is, by area, so that you get an integrated picture of all of our activities and then you can judge a lot better what the individual components look like and how good the individual grants are and what they serve and why they are important, and so forth.

Mr. Walgren. Is that because if the number of grants in a certain area tended to be below the threshold there would be no examination of that area, and if a large proportion of the grants in another area were above the threshold, there would be substantial occupation of time?

Mr. **Bloch**. That's exactly right.

Mr. **Walgren**. Well, let me ask Dr. Schmitt, why does it occupy all the time of the Board? I would initially be skeptical that it should occupy all the time of the Board. I would wonder whether there are not ways of streamlining that process without removing the responsibility to be involved in that kind of approval, if only because our system in this country is not to confer undiluted power on any individuals. And it would seem that the idea of forcing the interaction of the Director with the Board, each to understand each other and their own value system, would result in perhaps a more tempered decision and perhaps a better decision.

So my question is, being skeptical, why does it take so much time of the Board to do this, precluding you from performing the other functions that Mr. Bloch would recommend for you?

Dr. **Schmitt**. Well, in principle I assume the procedures could be established that would avoid inordinate spending of time on those things, and I agree with the implication of your question.

The fact is that what we are proposing as an amendment does not indicate the intention of the Board to abdicate its responsibilities to Mr. Bloch, as much as we might admire his direction of the National Science Foundation, but to be able to state from our own point of view the kind of criteria we would like to have established, whether dollar value or otherwise, on the kinds of things we want to review.

I'd like to add to what Mr. Bloch said. It is not only a matter of the bias of attention to our particular areas, but it is a matter of the timing of the Board's involvement in important decisions pertaining to programs. It tended to place too much emphasis on having the Board's involvement at the time when the grant was being approved rather than at the time when the program was in a stage of formulation and, from my point of view, also a followup on these new programs, I think, is extremely important for the Board—to spend time in seeing how some of the new initiatives in fact are working after they have been under way.

So it's not only a matter of the bias in terms of the profile of programs in the Foundation, but also a bias in the time of Board involvement in it. There's no question that, as your question implied, administrative procedures could be adopted. But I think it's highly advantageous to have the law indicate, in some way, its preferences for the way the Board spends its time.

My own experience, on coming on the Board, I have to say, was some surprise at the issues that the Board was paying attention to. It tended, because of procedures established in accordance with the law, to concentrate on what I regard as rather details of the proposals that came before the Board. I think the reason for this is a very simple one, namely, that those were the only kinds of things that the Board had the ability to talk about at that stage; it really hadn't been involved sufficiently in an earlier stage of program formulation, or in the later stages.

Mr. **Walgren**. Do you feel that it is a fair reservation to be concerned that the Director would not be tied into the Board? I, instinctively, am apprehensive that the Director would be able to really take the bit in his teeth and run, leaving the Board very much behind and unorganized—well, in somewhat a group body—

and that there is a salutory effect of having all directors interdependent on more than just their own judgment.

Dr. SCHMITT. Let me say that we intend to have Mr. Bloch accountable to us, and that we in fact will give strong indications and direct guidance in the kinds of things—may I go over the kinds of criteria that we believe are the kinds that we want to impose on Mr. Bloch to bring before us, issues, programs of the Foundation?

Going down our own thoughts on this, special policy issues, for example, such as new approaches to supportive research; establishment of new centers, institutes, facilities; any cases where there is a potential for a rapid growth in funding or special budgetary initiatives; when there is special sensitivity in the research community or some special sensitivity from the political point of view; previous expressions of the Board's concern; and otherwise selected by the assistant directors——

Mr. WALGREN. Now, could I ask, then—and this should be obvious, in all this, that it's not Mr. Bloch that I'm concerned about. In my short duration in this system we've seen a number of directors, and not only would I not be concerned about them, but I'd especially not be concerned about this one. I do feel, though that we're changing the law for future directors and the future of our appointees in that position, and my question would be, how are you going to make him accountable? You say, "we intend to have the Director accountable in these areas," but the question then, what are the mechanics of the accountability?

Dr. SCHMITT. Yes. Well, the mechanism for making him accountable would be through Board resolutions, presumably saying, "here are the things we want you to bring before the Board," so that he would be obligated to do that.

Mr. BLOCH. Can I add something here?

Mr. WALGREN. Sure.

Mr. BLOCH. Removing the dollar restriction still gives the Board full authority to delegate and to revoke delegation. It can delegate anything one day and revoke it the next day.

Mr. WALGREN. So what is being proposed is not that the Director have this power, but that——

Mr. BLOCH. That the Board has the power of delegation.

Dr. SCHMITT. I'm sorry if that wasn't understood. That's a very important point, and that is the basis for our recommendation.

Mr. WALGREN. That's helpful.

Let me ask then, also, about the vacancies on the Board. As I understand it there are a number that remain?

Dr. SCHMITT. Yes, there are. Some five now, I believe.

Mr. WALGREN. Five out of how many?

Dr. SCHMITT. Well, a total of 24 plus the Director, or 25 in total.

Mr. WALGREN. And this is because the White House has not approved recommendations of waiting nominees?

Dr. SCHMITT. That's correct, yes.

Mr. WALGREN. Why has that taken so long to get some of these vacancies filled?

Dr. SCHMITT. Well, I'm afraid, Mr. Chairman, that I personally cannot answer that question for you. Mr. Bloch and I are going to undertake to try to urge further action on filling those Board vacancies. It is important to us on the Board to have those vacancies filled because we are, in the direction we are moving with the Board and the Board activities, in need of having a full complement of Board members to get the responsibilities allocated properly. The Board members are only part-time, obviously, and we really do need them. So we are, in fact, going to attempt to urge the White House to fill those vacancies.

Mr. WALGREN. Well, we certainly want to support you in every sense along those lines.

Also we have vacancies in the Assistant Directorships and we have people that are certainly being distracted from their focus in trying to serve in several capacities. Would you recommend to the committee that those assistant directorships not require Presidential appointment?

Mr. BLOCH. I absolutely would, yes, and let me explain why I am saying that. I've been looking at this problem now for the last 5 or 6 months. I think filling these vacancies of Assistant Directorships is a very complex kind of a process because it's a Presidential appointment. If it were not, I think we could move a lot faster. It's important to realize that some of these openings have been there for a period of a couple of years; it's not just 2 months or 3 months or 4 months. It's a couple of years they have been open—some of them a year, some of them 2 years. And I think that's too long a period of time.

Because of the complexity of the process, people that are interested in it lose their interest after a while, No. 1. No. 2, they get other offers and they make a commitment and are not waiting for the whole process to be completed. Third, the selection is more complex if it's a Presidential appointment. You have to touch base with many more people than you would otherwise. So in order to streamline the operation, in order to focus and solve these problems, I think it's important to take it out of the Presidential appointment routine. I'm not saying that for the Deputy Director or for the Director position itself; I'm not making that point. But for the assistant director, which really are critical parts of the Foundation's management, I think that would be a great help.

Mr. WALGREN. Do either of you have any other structural recommendations to help NSF function to the best of its capabilities?

Dr. SCHMITT. Well, first of all, I would like to endorse what Mr. Bloch has just said very, very strongly. I think that it would help immensely in the effective management of NSF to remove the AD's from the Presidential appointment process. And after all, in an agency that has a governing Board of 24 people that are Presidential appointees, it would seem even less need to have the assistant directors go through that course. But I do agree that the Director and deputy should stay in that process.

In a structural way, I think that we have remarked to you on the structural changes that we have made in the Board. I think, given Mr. Bloch as the Director and his strong desire to work with the Board, the changes we have made in that recently are going to permit us to work more closely and more effectively with him in the issues before the National Science Foundation. We are attempting to get our committee structure operating more forcefully and more effectively, and I think that that is the key to better functioning of the Board.

Mr. WALGREN. You have the power to make those—not you personally, but the Board can organize itself into those committee changes that you outlined in your testimony, and I think, certainly personally, that you'll find a lot of encouragement to focus on the science and education function, as it seems to be thrust of that reorganization.

Dr. SCHMITT. Yes.

Mr. WALGREN. Well, the Chair would recognize Mr. Boehlert.

Mr. BOEHLERT. You know it's going to come, so it might as well come early.

Science Education. I'm concerned, and I think a lot of us are, about the proposed deferral, and I'd like to ask a series of questions dealing with that general subject area.

How about, Mr. Bloch, the money carried over from 1984? Has that already been expended in 1985?

Mr. BLOCH. Well, the money carried over from 1984 into 1985, which is part now of our 1985 budget, of that total amount, about $27 million in the area of precollege education has been committed. We still have a ways to go, in order to spend the money, but we have every intention and probably we have the wherewithal to do it, to spend up to that $81 million that I'm proposing, and carry the other $32 million over into 1986.

I don't quite know what you meant by, "have you spent that money that you carried over" because dollars are fungible, obviously.

So we are intending to spend $82 million in 1985; we are not going to spend the $112 million that we had allocated, including the carryover, and using $32 million to carry over into 1986.

Mr. BOEHLERT. I have the impression that perhaps you and OMB didn't see eye-to-eye on this. What did you actually request from OMB for 1986?

Mr. BLOCH. Well, what we requested for 1986 initially was a much higher budget than what we received. In fact, if I remember correctly, we requested $1.7 billion in total——

Mr. BOEHLERT. But science ed in particular?

Mr. BLOCH. And in science ed in particular we requested a higher number also, that's correct, than what we received. I think we requested something like $110 million or $116 million for science ed. But that was within the total budget of $1.7 billion that we requested from OMB.

If I can say just one more thing, just to highlight it, we got our first pass-back from OMB, which was a flat budget of $1.5 billion, the same as what we had in 1985. We protested that one, and we came out with the number which you see today, which is $1.6 billion with the carryover of the $31 million. Within that last number that we are now using as our bottom line, I felt it was advisable to do exactly what we did. And we allocate the dollars in accordance with the requirements, No. 1, and in science education make sure that we can spend the money in 1985 in a wise way and don't have an up-and-down situation from year to year but keep it on a steady kind of a path. And that's why we went into 1985 with the deferral idea, and moved that money into 1986 so that we could have a level budget between 1985 and 1986.

But in the end, it was my decision. I want to underline that. Obviously, I would have liked to see a higher budget for science education just like I would have liked to see a higher budget for everything else; but under the circumstances, I think that what we did was the best that we could do. We didn't get the $1.7 billion that we asked for.

Mr. BOEHLERT. How about specifically? How many proposals in teaching enhancement and informal education, and materials development are in the negotiating stage right now? I understand you have a number of very fine proposals.

Mr. BLOCH. We have a large number of proposals. First of all, the first thing that you should realize is that we have a carry-over from last year of proposals of about 300 or 400. We have another 300 or 400 that have come in new in 1985, so we have a total of about 800 proposals.

We know about what the quality of these proposals is because what we have now in-house is the thing that we have to work with for the remainder of the year. Any new proposals that are coming in now will not get through the evaluation process and the renegotiation process, and so forth, this year. So what we have is pretty much what we will have to work with for the rest of the year.

The quality is mixed. Some of the proposals are very good; some of them are very bad; some of them are in between. But looking at the total quality, looking at the fact that we are building up this particular directorate with new people, new people in a new area called precollege education, that what we can handle in a responsible kind of way is what we indicated in our budget proposal for 1986.

Mr. BOEHLERT. Well, supposing, Mr. Bloch, that Congress says no to the proposed deferral. Will you have the ability to prudently spend that $31.5 million?

Mr. BLOCH. I question that. If Congress says no to our requirement—and obviously, it's the right of the Congress to say no—we will try to do our best. But I have a really strong suspicion, and a very strong conviction, in fact, that we still will be carrying over dollars because we will not find a way for spending it in a prudent kind of way because of all the problems that I mentioned before.

Mr. BOEHLERT. Is my time up?

Mr. WALGREN. No. Why don't we break now and go vote and come back and continue with your time at that point?

Let me just say that there is a vote over there, and I'm afraid that this is what happens from time to time. It'll take us 10 minutes plus a little to get back, so we'll take a 10-minute break.

[Recess taken.]

Mr. WALGREN. The Chair would recognize Mr. Boehlert to resume.

Mr. BOEHLERT. To continue, Mr. Bloch, I can appreciate the problems that you've had in gearing up and getting your staff aboard, and I understand your basic premise that you don't want to rush ahead and in the process, perhaps, not spend the money that is allocated judiciously. But can we be assured—raise your right hand and make a solemn pledge—that this science education will get the priority attention in the coming year that we all feel that it deserves?

Mr. **Bloch**. Well, you definitely can be assured. And let me make a very personal point, I probably have spent more time myself on this particular area since I have been here compared to any other area. So it's a very important one. We're putting the right people in there. We have an assistant director, Dr. Shakhashiri, who is eminently qualified to head up this area. He has a long history in education and it has been his concern before he got to Washington, so you can rest assured that we are keeping the focus on it, that we are doing the right things. But on the other hand, I want to make sure that we are doing the right things in a constructive kind of way so that we are building for the future and not just solving a problem right this minute, and then forgetting about it next year.

Mr. **Boehlert**. I understand.

Mr. **Bloch**. It's a problem that will be with us for some time.

Mr. **Boehlert**. Yesterday we had three very distinguished panelists, Dr. White, Dr. Hamburg, and Dr. Rosenzweig, and I asked each of the three—and they all said it was a good budget, a sound budget, and urged that we support it—but I said, what's missing? If you could add something, if you could place some added emphasis in one area, what would that area be? And all three said "graduate fellowships." How many are provided for in this budget submission?

Mr. **Bloch**. Well, in this budget submission, what I showed you before on chart 8, you see essentially what we have there. We have graduate students, 11,000; we have 3,200 postdoctorals; and we have 14,000 senior scientists. In addition to that, in the science and engineering education area, we have another 1,500 for fellowships. So we support a significant number of people and all of these areas have seen increases, increases in the numbers, that I wanted to point out.

Mr. **Boehlert**. Would you like some more?

Mr. **Bloch**. I would like some more on everything, yes.

Mr. **Boehlert**. What single area would you place added emphasis on if you could have your druthers? If you could direct us to, in one area, add some more? Would it be instrumentation? I know you've placed a great deal of attention on that.

Mr. **Bloch**. Yes. I would think I would focus on instrumentation and facilities as a high priority area.

Let me say something about it. And, again, it has to do with priorities. I think if you put things in priorities you've got to realize first that personnel, people, scientists, engineers, especially future scientists and engineers, should get our highest priority. The second area that needs priority is instrumentation, and the third area is finally facilities, maintenance as well as new facilities. But I think it has to be almost in that kind of a priority.

Let me just say one thing on the facility question because I know it's being discussed all over and was probably mentioned yesterday, also. Facilities are a very important kind of a subject. It's also a very costly area. If you add up all the dollars that you need for facilities, it's much more than the budget of the National Science Foundation. So I think the National Science Foundation by itself can only play a small role in that, as we are constituted today, but I think the Government in total has to really take on the facilities aspect as a major kind of a problem that doesn't necessarily have to be solved or can be solved in 1 year, but over the next few years. But I would put it in this priority—human resources first, instrumentation next, and facilities third. And if we had more dollars available, we probably would focus on instrumentation very heavily.

Mr. **Boehlert**. I've got a lot of questions. I don't mean to monopolize, but I'll take advantage of the situation; my colleagues aren't back yet.

I've heard from a number of my constituents, and you could probably name them, about the zeroing out of the Division of Policy Research and Analysis and the EVIST programs. They are concerned; because they are concerned, and I am impressed with their credentials, I equally am concerned. Are you concerned?

Mr. **Bloch**. Well, you're really asking two questions, so let me separate them.

I didn't cancel out the Policy Research and Analysis Program. I cut it in half, so I don't call that zeroing out. Second, the Policy Research and Analysis Program has a large number of people and a large number of dollars in it, and I think we can do the same amount of work if you prioritize it right with less of a staff and with less dollar expenditures.

Now, on the EVIST Program, which is a separate kind of a program, yes. I canceled that out to zero; that's absolutely correct, and let me tell you why.

First of all, I think that program has been around for a long period of time. It has done some very good work. Much of the work that it has accomplished and that it is doing is being taken over by other people; it has a life of its own. Some of the journals that were started are today self-supporting kinds of journals in this particular area of ethics and value in science and technology. Some of the work, some of the research that should go on there can go on in the rest of the Foundation by competing, head to head, with some of the other submissions, especially in the behavioral and social science area, which has a tremendous increase this year, about 19 percent increase in its budget.

So I would hope that the people that have had a sheltered kind of a program—let me put it that way, and that's not a derogatory kind of a comment, it's a statement of fact—I think should get into the mainstream of things. That was the reason why I terminated that particular program. No reflection on the work, no reflection on the importance of it, but I think a lot of it is stand-alone. A lot of the professional societies have taken over some of the aspects of that particular work. Whistle blowing was one of the big issues that went on in EVIST. I think that is a recognized kind of problem, and a lot of the professional societies and scientific societies are concerned with it.

So I think that there always comes an end to everything, and this was the end for EVIST.

Mr. **Boehlert**. Well, it may not be——

Mr. **Walgren**. It may not be the end after all.

Mr. **Boehlert**. That's right.

One last question, if I may ask Dr. Schmitt a question about Science Education. I'm particularly concerned, obviously, with precollege and then with undergraduate. What guidance would you give to your associate at the table and to his colleagues at NSF to gear up and get moving on this?

Dr. SCHMITT. Well, in the first place, the number of dollars you're talking about devoted to Science Education in the National Science Foundation budget is very, very small compared to the total resources devoted to education and the total resources needed. So, in my opinion, the key factors in that program have got to be ones of quality and leverage and leadership. And I think that Mr. Bloch's emphasis on being sure of that, of having the management team in place to do a good job of having good proposals to deal with and of administering them well and of learning from them, is exactly the right priority.

The total number of dollars—you know, whether it's $80 million or $110 million—is not the key factor in the National Science Foundation impact on this area, in my opinion. So I would simply urge him to continue strongly to pay attention to the quality and leverage of the programs that the Foundation carries out in this area.

And I would like to remind you of what I said earlier, that at Erich's strong suggestion we have formed this committee of the Board now on Education and Human Resources which I think will give the Board a lot more oversight impact and influence on those areas. And I'm especially pleased to say that Sy Ramo, who is a new member of the Board as of last May, has agreed to be the chairman of that committee, and he has a strong, strong interest. His statement is very simple. He says, "That committee deals with the future. The Programs and Plans Committee deals with the present." And he is chairman of it; Homer Neal, a long-time member of the Board, Provost of SUNY at Stony Brook, is the vice chairman. I think we have a very strong—and it will be a very effective—committee to work with Mr. Bloch in that area.

Mr. BOEHLERT. Thank you both very much. I have exceeded my time. Maybe I can get back after everyone else has had their opportunity.

Mr. WALGREN. Thank you, Mr. Boehlert.

The Chair recognizes Mr. Ritter.

Mr. RITTER. I thank the chairman and I thank Dr. Bloch and Dr. Schmitt for their excellent testimony, and I appreciate the tendency to take some new looks at the role of NSF and how that role can be optimized in meeting the kinds of challenges that we are now convinced, and we have consensus on, that we face today.

I'd like to just follow up on Mr. Boehlert's last question, simply because it's fresh in everybody's mind and it's Science Education. It was my third question, basically.

I'm very pleased that a Committee on Education and Human Resources has been set up and that a man of Simon Ramo's caliber has been selected to chair this committee.

You talked about leverage, Dr. Schmitt, in this effort, and the Science Education in Secondary Schools is such a large endeavor that only leveraged activities would have a perceived impact. There are many people who are saying today that perhaps the crucial problem in Science Education in the Secondary Schools is the incoming lack of qualified teachers in physics and chemistry and in mathematics, and especially in the public school system where the reward systems are defined more by bureaucratic approaches than market approaches. And we know for a fact that engineering universities, particularly State universities and other universities that try to standardize salary structures and put them in lock-step motion year by year, and certification and then entry level and beyond, immediately found themselves out of the market for new engineering faculty and the adjustment have had to be made in the good universities. And, hopefully, some of those universities, State institutions who are still back in the old system, are understanding that it's really dysfunctional in terms of hiring new faculty; one must pay attention to market forces.

Well, the universities are learning this, have learned it, but the public school system operates in a very different way. I was just wondering whether or not greater attention to market forces, given some of the institutional opposition—and I think it's widely accepted that the National Education Association is not enamored of differential reward structure based on, perhaps, different fields—is the National Science Foundation education program, in its attempt to leverage the system, in its new committee, going to consider this—as we call it, first-order effect—in some detail?

Dr. SCHMITT. Is that question addressed to me?

Mr. RITTER. Well, I think it's a question that's addressed to the Chairman of the National Science Board which is trying to develop longer range views of the system, yes, and then to the Director.

Dr. SCHMITT. Well, my response to that has to be premature because this new committee of the Board, which I hope will address fundamental issues of that sort, is only formed and Dr. Ramo has only begun his actions on that, so I hope that the next time we appear before you we can give perhaps a better, more definitive response to that question.

Mr. RITTER. I would recommend that that be a very fruitful area for investigation, and that there are certain locations around the country which have attempted to use market forces and have found some of their shortages drying up and—lo and behold—they haven't even had to raise taxes in the process. It turned out to be a matter of flexibility within a large system, and the numbers and the volume of dollars were not that great. But I would encourage the Board to look into that.

Dr. SCHMITT. I just have to remark that I think that, given Erich Bloch's and my own background, you don't have to sell the value of market forces to either one of us——

Mr. RITTER. I am indeed pleased that that is the case.

Mr. BLOCH. Let me just comment on it also, and I think you're making an excellent point. Let me just reflect on the situation in universities. It took a very long time before universities got themselves to the point where they are now, today—not all of them, but a great portion of them, are offering differential salaries and also inducements for those areas where they experience faculty shortages.

To me, the gratifying part in watching that over the last 2 or 3 years in particular is the fact that not only private universities, which have an easier time in doing that, have done it, but really the lead was taken by some of the State universities. Arizona, for instance, took a tremendous step forward in that; University of

Wisconsin; and a lot of other universities. And I think that particular example probably could help us in the area that you are addressing, and I think I want to take that under advisement, No. 1, and also see what we can do within the restrictions that we have ourselves. We are not a free agent, obviously; we can't do just everything we want to. But one can bring to bear on this particular problem so that the market forces themselves become more prevalent in attracting and selection of teachers, especially in those areas that have a quality and a quantity problem.

Mr. Ritter. Thank you.

You mentioned your individual proclivities toward introducing a greater market force within this large system, and I appreciate that. I have been looking at the composition of the National Science Board, and I'm pleased to see that the new chairman is from the private sector so that we have some, I think, modification of the steering mechanisms that drive this massive Federal R&D economy, and the National Science Board is—as we understand it—the steering mechanism for NSF. But there is a greater industrial competitiveness, private sector view of the long-range direction in which basic research is performed within the National Science Foundation.

But if you look at the composition of the overall Board, it is largely representative of the major American universities, obviously representing—you know, sometimes where you stand depends upon where you sit—and I would suspect that greater balance within the Board could help NSF to perhaps steer more in the direction that I think everybody understands is out there, and the rationale behind engineering's research at NSF and at the Engineering Research Center.

I'd like some comment as to why the Board is so heavily weighted and if, perhaps, we may be seeing changes in the wings as to the composition of the Board, private sector vis-a-vis university professoriat.

Dr. Schmitt. Yes. Well, you are correct at the present time; the balance is some 12 academic, 5 industry, and 3 other.

Mr. Ritter. Are the others Government agency and nonprofit; is that how you classify that?

Dr. Schmitt. Well, Mr. Bloch is one of the 25 that I'm talking about. Don Rice, president of RAND Corp., and Bill Miller, president of Stanford Research International are the others.

I would like to say that I think it is extremely important that the Board have a balanced membership in several respects, with respect to discipline as well as with respect to industry and academic. I don't find the Board to be especially unbalanced in that respect at the present time. I think that most of the people on it have fairly broad perspectives, whatever their origin, but the principal clients of the National Science Foundation are indeed the academic institutions of the Nation. And so, in my view, it's extremely important to have a very strong representation of those institutions on the National Science Board. And speaking as an industrialist, myself, I don't feel any imbalance in the nature of the discussions that we have on the Board concerning issues today. I think it's something that needs to be watched. I don't think it's a present problem and I don't anticipate it to become a problem.

Mr. Ritter. I guess my interest stems more from an overview of what I perceive to be a Federal R&D economy having emerged over the years, very successful, it's integrated with the Defense establishment, it's integrated with the university R&D community; and I guess what I was thinking was that, given to some extent the nature of our competition in this new race for preeminence in the 21st century, that perhaps the steering mechanisms—and you have NSF, you have the national laboratories, you have the Defense R&D components—it would occur to me that we all—people say that basic research—some people think that basic research kind of comes out of nirvana, and it's like the message from on high, that is, the directions in which the National Science Foundation or other Government agencies will take. But of course, there are constituencies which define research. And I guess my view is that some privatization of the steering mechanisms are perhaps in order.

Mr. Bloch, you might wish to comment on that?

Mr. Bloch. Well, I agree with Dr. Schmitt in his remarks about the Board composition. I think the Board is not unbalanced today. If you look at the numbers—but you really can't just look at the numbers. You've got to look at the individuals and their participation in the Board.

Mr. Ritter. I've got my numbers, by the way—I've only got the present composition of the Board—I've got Dr. Mary Goode from UOP, Des Plaines, IL; I've got Dr. Schmitt; and I've got Mr. Robert Gilkinson, and everybody else on the Board——

Dr. Schmitt. But you don't have the latest part. You don't have Sy Ramo, for example, and you don't have——

Mr. Ritter. No; I don't have the latest appointees.

Dr. Schmitt [continuing]. And you don't have Siva——

Mr. Ritter. Sy Ramo is one of the latest submitted names, and who is the other one?

Dr. Schmitt. Dr. June Lindstedt-Siva——

Mr. Ritter. And from—Arco?

Dr. Schmitt. That's Arco.

So, at the present time, Gilkinson, Goode, Lindstedt-Siva, Ramo, and myself.

Mr. Ritter. OK. I guess that that proves the point that I am trying to make, and that is that up to this present new presentation of the Board members, basically, out of 21 people——

Dr. Schmitt. Twenty-one? It was 19?

Mr. Ritter. Well, 20 active out of 25 right now, and 3 are from the private sector. And I am pleased that you are moving with some greater balance toward some privatization of the steering mechanism of the Foundation.

Mr. Walgren. The gentleman's time has expired.

Mr. Ritter. Oh, could I have one other question? I noticed the time limits were not there for the others, although I have taken a few minutes, that's for sure. Could I ask one more question?

Mr. Walgren. Sure.

Mr. Ritter. I am concerned about research in this area of the policy research and analysis, PRA, and we have talked, Mr. Bloch and I, on this. But I would like to make very clear that the area of putting hazards in their proper perspective and basing some of those decisions that public policy has to make on good scientifically based risk assessment is crucial, and that so far NSF is the only arena in this Government that's been doing some of the good work; and I for one would not wish to see the experiences and the capabilities and the responses that have been built up by the NSF program diminished by a budget reduction which is really quite small in its absolute value, but impacting on this area could be very substantial. I think we face a crisis in this country in terms of the public and the regulatory agencies and their response to public outcry, being able to put risks and hazards in some perspective. And I think we've lost track or lost hold of some major American-developed technologies because of some of these situations that have evolved. And risk assessment and putting hazards in perspective in some comparative sense offers some hope to get out of this crisis situation.

I'd like to just have this dialog with Mr. Bloch on this issue because I think it's awfully important. I know that there have been responses to place some of these programs into the more disciplinary program directorates, or whatever they're called, but I would hate to see these kinds of—they are more integrative, they're more global than sometimes disciplines tend to be—efforts fall away from NSF purview because there's no real possibility out there to pick up this slack.

Mr. Bloch. Well, let me answer the question, and we have talked about that before privately, so I understand your concern and I appreciate your concern, and I share your concern.

Please do not equate policy research analysis with risk assessment. Risk assessment was one part of a Policy Research and Analysis Department. Point No. 2, the risk assessment aspect is broadening within the Foundation. For instance, the Biological, Behavioral and Social Sciences Directorate under Dr. Kingsbury is playing a very important role in this particular area because it fits into biotechnology, and so it is concerned with biotechnology in a very direct kind of a way.

Mr. Ritter. If I could interject just there, we would not wish just to limit risk assessment to biotechnology but the whole chemical industry and its implications there might not be picked up by Biological Behavioral Sciences.

Mr. Bloch. I agree with you, and I didn't mean to say it in that particular sense. My only point is that this whole area of risk assessment, as it applies to chemistry, as it applies to biotechnology, or anything else, the environment in general—what the NSF can do and can do best is provide the underpinnings for risk assessment, the methodology, the tools and the generic kinds of solutions, that have to get implemented by the individual agencies that are looking at a very specific kind of an area.

You should also know that under Mr. Ruckelshaus, before he left the Government—and I know that this is going to be continued—there was a subcommittee of the Cabinet Council in place, and I am a member of it, to essentially oversee the risk assessment area and the risk assessment activities across the whole spectrum of Federal agencies. And again, my role and the role of NSF is to provide some of the underpinnings. We are right now in discussions with OSTP on exactly that particular problem. How are we going to focus the efforts of OSTP and ourselves, EPA and so forth, in this particular area on what our role is.

But I really would like you to look at the total Foundation's effort rather than just one particular department's.

Mr. Walgren. In view of the fact that the bells have rung, I really want to give Mr. Bruce an opportunity to ask some questions, and we will be back for another round, Don, if you like.

[Recess taken.]

Mr. Walgren. The Chair would recognize Mr. Bruce.

Mr. Bruce. Thank you, Mr. Chairman.

My questions deal with the NSF's supercomputer centers. I wonder if you could just give us a little insight as to the long-range strategy you have for those, and I understand you're going to make a decision tomorrow as to three additional sites. I wonder if you can tell us the funding for those. Are you going to name two additional temporary sites tomorrow, along with three permanent sites, and the funding at either the temporary or the permanent for tomorrow? If you would just tell us a little bit about the procedure under which—not only the long-term strategy you have for those as national/regional sharing of the information, but also the procedures under which you will make the decisions.

Mr. Bloch. Very good. First of all, let me start off with 1984. In 1984 we put in place a number of sites which are not 100-percent dedicated—quite far from it, in fact, to NSF and NSF clients—but what we are buying from those centers is really time on existing supercomputers in order to move very rapidly into this particular area instead of having to build up a new system. And those are three sites that we are buying time from, and we are extending that to five sites—five or six sites total—so that we have an adequate supply of hours available, first of all in 1984 but also in 1985 and 1986.

However, the big emphasis and the big dollar outlay is on the permanent installation. As you know, we went out with a solicitation to which we got 21 responses; and if you add up the total dollars, if we would fund all of them over the next 5 years, it would be roughly over $1 billion, so a very large amount. Obviously, we cannot afford—neither should we—fund 21 centers.

We have looked at these proposals very thoroughly. We had a peer review committee in place to review all of the proposals. They grouped them in order of priority in terms of excellence of the proposal itself, what and who they are serving, what kind of individuals and disciplines and so forth they serve, how well they are managed—which is a very important aspect of these centers—and from all of these respects, a number of proposers' institutions were visited in order to gain more experience and gain more insight in what they want to do. And now we are ready to make a decision. It's going to the National Science Board, as you said, tomorrow for a decision. Our proposal—and that's all it is right now, because I don't know how the Board will come out of it—is essentially to establish the following centers: three of them that will be general-purpose kinds of supercomputer centers; a fourth one which is using more of an experimental configuration than the other ones, but a very important experimental configuration so that that kind of a configuration can be tested in a true scientific environment.

Also we have at our disposal, thanks to Congress' action last year, a machine from NASA, it's a Lewis machine, that will be available toward the end of the year. We are trying to use that machine as a cornerstone for an additional center, a fifth center, with an idea of updating that machine over time so that it stays at the forefront of technology.

So that is essentially what we are proposing. That, together with the networking which has to go hand in hand, will essentially use up the dollars that we have available, $40 million this year, $45 million next year. And with that one we're going to close out the competition.

So that's about where we are. With respect to your question on long-term strategy, I don't have a fixed number but I would think that we need in the future, over the next 3 to 5 years, we probably have to wind up with something like 10 to 12 centers in total in order to handle the requirements that we have for this kind of a facility. So that would be the long-term trend.

One more long-term trend, we have to interconnect these centers, we have to network these centers in order to make them easily accessible to everybody that needs access to them. We probably also have to interlink them on an international kind of a scale because similar kinds of centers and networks in universities are springing up in Europe and in Japan also, and I think it's a good thing to interconnect these centers.

Mr. BRUCE. Thank you, Mr. Chairman.

Mr. WALGREN. Thank you, Mr. Bruce.

I had some areas that I wanted to touch on too, and we have a couple of minutes before we have to go and vote but I don't want to require the other members to come back.

Don, would you like to take the next 4 minutes or so, and then we'll break? And then is it possible to resume at about 10 minutes after 12 for a short period of time? I don't intend to go very long.

Mr. BLOCH. Absolutely.

Mr. RITTER. Thank you, Mr. Chairman. I appreciate that.

One of the major issues that we're all grappling with is engineering faculty, and that has something to do with, I believe, the engineering Ph.D. pipeline which we have seen diminish in recent years. We talked about this at the hearings the other day, the differential between industry's starting salaries and Ph.D. levels is not that great in a large number of fields. In some fields, it's quite great. One field that was mentioned to me the other day was like 26 to 27 and 35 to 38—it's not like the differential between pre-med and medical school, obviously, or prelaw and law school.

Some say that part of the reason for this is that the Foundation, in its fairly dominant role at the universities and in the research portfolios of the professoriat, has taken a science approach to engineering and it's been a kind of engineering science approach to a lot of these subjects. And that the marketplace is not necessarily seeking, in today's marketplace, that engineering science as much as it's seeking just a high level of capability in the engineering applications ends and in those kinds of fields or the research in those more applications-oriented fields—not necessarily applications, but away from the science toward the engineering.

I wondered whether or not—how you felt about this.

Dr. SCHMITT. I would be pleased to comment on that.

Basically, if we're talking about the Ph.D. population in engineering, at the moment, there are two problems there. One is the lack of faculty at the present time at the universities to train those, and the second is the very high proportion of foreign nationals among the Ph.D.'s. So there is a real limitation——

Mr. RITTER. Do the foreign nationals have a greater incentive to go for that Ph.D. because it gets them a little more of a head start in a situation where the research lab may be more amenable to them, whereas the bachelor moving up that 6-year period while the Ph.D. program is underway is making strides in a social/economic/technological mix that the foreign student doesn't necessarily have at the beginning?

Dr. SCHMITT. Yes. Yes, that, I am sure, is true. But the point that I wanted to make is that from the point of view of industry, it is a very tough call because of our need for engineers in particular areas. We may sometimes lure people away from graduate programs that would otherwise go on. And I think this Presidential Young Investigators Program is an absolutely outstanding illustration of the way in which that could be rectified, to a considerable extent, with industry cooperation.

So I have very high hopes for that contributing significantly to the resolution of that issue.

Mr. RITTER. So that the definition of research at the Foundation itself, if engineering receives it for greater emphasis, will help, I believe, to take care of some of these problems. And NSB, that has some private sector motivations and orientations within it, will help to take care of—it's going to be a long-range problem. It's not going to be solved in 2 years.

Dr. SCHMITT. You've commented a couple of times on the industrial involvement in NSB, and let me just state very quickly that I think one of the absolute strengths that the American science/technology system has had is the very, very strong academic research programs in this country. It is unique to this country. There is no other country in the world that has the same strength of academic research, in engineering as well as sciences, and also has been connected to industry. It is those two facts that we tend to overlook sometimes, on the competitive strength.

Mr. RITTER. I'm sorry, I'm going to have to vote. I'm trying not to overlook it; what I'm trying to do is—there are some really sharp, harsh realities out there today and maybe there can be some creative changes in our system that help us to meet those realities.

Thank you very much for your joint testimony.

Mr. WIRTH [acting as chairman]. Mr. Bloch, we're having a continuing "moveable feast" here. which I'm sure you appreciate, to get in and out and not having to wait for votes.

Yesterday, when Dr. Hamburg and others were here, and I'm sure there have been references to that, there was some discussion of the $31.5 million deferral that's in the NSF budget. That came up briefly today.

Now, the concern that a number of us have relates to two questions. One, how fair is it that that deferral come out of just one section of the NSF budget? I understand that it's the science and engineering education section. Is that right?

Mr. Bloch. Yes. That's correct.

Mr. Wirth. Should that be spread more broadly across the NSF budget, if you wanted to defer $31.5 million? Should that be spread more broadly?

Mr. Bloch. Well, my answer obviously is no: it's right that it comes out of that particular department. And the reason for that is very simple. The reason for that deferral in science education is exactly what I stated before, and let me repeat it.

It's essentially in recognition of the fact that this is a department that is in the building-up phase right now, has a lot of new people in it, a lot of new activities in it; the focus on precollege, essentially, is a new kind of a focus. Third, the recognition that over the last few years, since 1983, to be very specific, from 1983 to 1984 to 1985, the increases in that particular area were very significant. They went from $1 million in precollege education in 1983 to about $37 million in 1984 and now to about $54 million in 1985. And the third reason essentially is that the responses and submissions to the Foundation that we have in place today, about 800 total, 400 carryover from last year and 400 new ones, are of a mixed kind of quality. Some very good, some not so good, and some of them in between. And if you look at the totality of where we are today, in terms of the people that we have brought on board in terms of the focus on a relatively new area for the Foundation—a very difficult area, by the way, I need to say—and the third one, if you look at the proposals we have gotten, the workload that's in place, I think it's prudent to curtail the dollars to the $82 million level in total that we are intending to spend, and then postpone the rest of it into 1986.

Mr. Wirth. The teacher training program went from $1 million in 1983, you say, to $37 million in 1984 to $54 million in 1985?

Mr. Bloch. Well, it's more than the teacher training program; it's really the total area of precollege education programs, which includes the teacher program.

Mr. Wirth. OK, $1 million was spent in fiscal 1983?

Mr. Bloch. In 1983, yes.

Mr. Wirth. And $37 million was spent in——

Mr. Bloch. And $37 million in 1984, and $50 million in 1985.

Mr. Wirth. And what was the deferral that existed between 1984 and 1985?

Mr. Bloch. The deferral from 1984 into 1985 was $31 million also.

Mr. Wirth. Now, why was there a deferral in 1984-85 of $31 million, and then again in 1985-86? Isn't the Congress telling you that the Congress wants you to focus money on secondary schools, science teaching, and science education?

Mr. Bloch. Well, the deferral from 1984 into 1985 was for similar reasons. Essentially, that it was a new, reestablished directorate that needed to build up, needed the experience, needed new people and new training. And the same is happening from 1985 into 1986.

Mr. Wirth. So you deferred in 1984-85, and then 1985-86.

Mr. Bloch. Right.

Mr. Wirth. I thought one of the things that the President has been telling us is that there is a significant reason for upgrading American secondary education. Mr. Bennett has been making a variety of statements about the quality of education in this country, the Congress has responded by saying that it wants this administration to spend money on secondary school teaching and science and the enhancement of science education. Your response appears to be that this is not the kind of priority you want to spend money on, but you deferred $31 million this year; you are prepared to do it again in the coming years. Now, how are those consistent—how is the rhetoric consistent with the budget?

Mr. BLOCH. Well, first of all, I'm not saying at all—and the deferral should not be interpreted to mean—that I don't believe that this is a high priority area, because that is not the truth.

Mr. WIRTH. Then why have you held up the program? I mean, you say it takes a long time to build up the program and you've gotten away from it for 1 year. Are you going to build up the program? When are you going to do it?

Mr. BLOCH. First of all, I think that we have to ensure that we have a quality program, No. 1, and not just spending money for the sake of spending money. And that we spend it in the right way, in the right areas so that it's a coherent kind of a whole and that we can continue that buildup of this very important area. And I agree that it's a very important area over the next few years, and have a continuity in this whole enterprise called science and engineering education. So it's not demeaning of that area at all, quite the contrary, I'm very conscious of the problem.

Mr. WIRTH. I would suggest—you know, I would hope that that is your priority——

Mr. BLOCH. Yes, it is.

Mr. WIRTH [continuing]. And that we are seeing that kind of emphasis. And the reason that I asked the questions yesterday and am again today is that it seems to me that if one does any kind of cursory review of American education, the crisis of science education at the secondary school level is very real.

Mr. BLOCH. Yes.

Mr. WIRTH. And one of the major pieces of that is how we are going to retrain teachers, or attract teachers—probably do more of the former than the latter—it has been very difficult to attract competent teachers to come into the science area in secondary schools in this country. I think that's pretty well documented as well. And that is going to demand a real push on your part, I think, in working with State departments of education who are equally, if not more, concerned.

Mr. BLOCH. Let me assure you, and I assured Mr. Boehlert the same way before, before you came in, that it's a high priority with the Foundation, it's a high priority with that particular directorate, and it's a high priority with the Director. And it's a high priority with the Board.

Mr. WIRTH. But most importantly, it's a high priority with the Congress——

Mr. BLOCH. Yes, sir, I recognize that.

Mr. WIRTH [continuing]. And that is there for a reason.

Can you tell me what you've been doing to respond to the priority that was discussed at the time of the authorization on the floor last year between Mr. Gregg and Mr. Walgren which focused on the potential uses of television and electronics in science education for the young?

Mr. **Bloch**. Well, that's one aspect of the focus on precollege education; not just the content of what is being taught, not just the education and background of the teacher itself, but also the delivery vehicle——

Mr. **Wirth**. I'm aware of how it fits in. Let me ask you the question again, what are you doing to——

Mr. **Bloch**. Well, we have looked specifically at that particular area, and maybe I can call on Dr. Shakhashiri to be very specific on that point.

Do you want to talk to it?

This is Dr. Shakhashiri, who is the Assistant Director.

Dr. **Shakhashiri**. We're taking a very hard look at the programs that deal with the informal science education areas that involve television. We have supported in the past, and continue to support, "3-2-1 Contact," which is a very successful electronic media approach to carrying the message about science education.

We have a variety of other programs that are under review right now that deal with this issue.

Mr. **Wirth**. Well, let me suggest that, as you are talking about a $31.5 million rescission—and I might suggest this to you, Dr. Bloch, as well—there is an enormous shortfall of programming in public television alone, "3-2-1 Contact" as well as a whole variety of other programs "Sesame Street," for example, is now, I believe, two-thirds repeats; "3-2-1 Contact" is running at about 50 percent of what it would like to do in terms of new programming. And while the argument can be made, Mr. Bloch, related to not being able to move funding in an effective fashion, it seems to me that we know that the impact of television on children is significant. The scientific education through children on television is well known; that as we know more about that, we know more about the power of television, and we know that there is enormous demand out there in the marketplace for this kind of programming. Now, if you're having trouble reflecting the priorities of the Congress and spending money, why don't you then turn around and spend a few paltry dollars to help with "3-2-1 Contact" and other programs focused on kids?

Mr. **Bloch**. Let me say one thing right from the beginning, that "3-2-1 Contact" is being funded in part by the National Science Foundation. So we have been involved in it.

Mr. **Wirth**. Oh, I know that you have been; I'm very aware of the fact that you have been. But by all of the testimony coming from the Children's Television Workshop, Corporation for Public Broadcasting, and elsewhere, there is a very significant shortfall of funding in the area of public television for educational programming focused on young people, particularly in the science area. That is one of the jobs of the National Science Foundation and that is particularly the priority of the budget in teacher enhancement and informal science education.

Therefore, why do you defer all the money? Why not take some of that money and put it into other kinds of programming where there is a very clear, defined, well-understood need for doing it?

Mr. Stockman claims that he wants to kill public television. Is that what you want to do?

Mr. BLOCH. No, I have no interest in——

Mr. WIRTH. Well, then, why don't you spend some money in this particular area doing the job that is well-defined? You don't have to take time to get it up to speed; it's right there, the need is very, very clear. Why don't you do it?

Mr. BLOCH. Well, I think you're making a good point. The point I——

Mr. WIRTH. Good. Let's go on to the next issue. [Laughter.]

Mr. BLOCH. The point I wanted to make, however, was also that, you know, we are looking at more than just public television in this particular area——

Mr. WIRTH. Oh, I know that. You have already made that point; I'm just giving you a very specific item, Mr. Bloch, and maybe we could get you to do that. I'm sure that Judd Gregg would like to see that happen, and I know that Chairman Walgren's interested in that, and we know that there's a very significant return. You know, if we're going to play cost effective education, you use all of the Reagan arguments about cost effectiveness, and this is a very good one where a little bit of money, as I believe you know, goes a long, long way in terms of impact. This may be the most cost effective thing that we could do.

Do you have any comments on that, Doug?

Mr. WALGREN. Just along the same line, it would seem that particularly with respect to this program, and also as I understand it others, there would be no reason to carry over funds in future years from the science education effort, and that is what I wanted to understand. We've had 2 years of carryovers now; we've had good programs like "3-2-1 Contact" that are immediately ready to receive more funding. And the evidence from the witnesses yesterday was that there was a host of good science education programs that are there, ready to go.

Do you see any need to carry over any funding from 1986 into 1987, especially given the fact that you requested more money than you were given this year for the science education effort? I would think you would be able to say that you would not anticipate any carryover beyond Fiscal '86.

Mr. BLOCH. I have no intention of carrying anything over from 1986 into 1987. When we came up with the budget, with the carryover from 1985 into 1986, we asked ourselves the question, as I have repeatedly stated this morning: How much of the money can we spend for quality kind of programs? That's our best assessment. We will make every effort to make sure that we are not carrying over beyond the 1986 fiscal year. And there is certainly no intent in doing so. Quite the opposite.

Mr. WALGREN. Can you go beyond not having the intention to do so, because apparently it was stated in previous years that there was no intention to do this, and then despite the strong direction of this committee and the Committee on Appropriations, nonetheless, carryovers were made.

Mr. BLOCH. I don't know what you mean by that, but let me assure you again that we have no intention of carrying anything over beyond 1986, that we think that with the programs that we are putting into place, with the people that we are putting in place, with the experience that we are gaining, that we can handle that amount of dollars. So I would categorically say, we have no intent, No. 1; and No. 2, I don't expect that this will happen. Can I absolutely guarantee it? No, I can't absolutely guarantee it, but obviously we make the best effort possible, and I think we will succeed.

Mr. WALGREN. But having gone into the budget cycle this year, and your requesting more money for science education than you ultimately wound up with allocated in the OMB budget, you would look pretty—I don't know what the right word would be—if you were not able to properly spend even less than you requested. So the egg would be on your face at that point, is that right?

Mr. BLOCH. I think the word you look for is "foolish."

Mr. WALGREN. OK. [Laughter.]

Mr. WIRTH. If the gentleman would yield.

Just in your argument that you didn't have good programs to spend the money on as the reason for the rescission or the deferral or whatever we want to call it, we know that there are a lot of programs there that are well known as being sound, good programs. The only point that we would make is knowing that, following your own argumentation and following the rationale for being as cost effective as possible, we would hope that you would again look at the possibility of supporting not only 3-2-1 contact but that whole family of programs that are there and are in very, very significant demand.

Mr. BLOCH. We will certainly take that under advisement.

Mr. WIRTH. Can I ask you a little bit about supercomputers? Is that an area that we might get into?

Mr. BLOCH. Sure.

Mr. WIRTH. I know that you had previously outlined, Mr. Bloch, what you intended to do. You may remember that last year we had a significant hassle on the floor, as I remember, the National Science Board had recommended that $200 million be spent in the supercomputer area. The administration had come in and recommended something in the neighborhood of $15 million to $20 million. The Science Committee had originally hoped that we would spend at least $60 million, and ended up something in the neighborhood of $40 million. At that point we did not, I guess, agree with the administration on the relative importance of funding going into the area of supercomputers. Is that now sorted out? Are you spending that $40 million, and do you believe, spending it effectively?

Mr. BLOCH. Well, the budget for 1985, as you say, is $40 million. We intend to obligate those $40 million and we have every reason to believe that we can do that.

Before you came in I described the process that we went through in solicitation of proposals, the proposals that have come in. The proposals have been evaluated and they are going to the Science Board tomorrow for approval. Depending on that approval we would be ready to announce what we are going to do the following week, on Monday of that week, if no hitch develops in the Science Board.

I think the programs that have been selected by peer review are the right programs. They are worthwhile to do; they are very important to do, and they will really occupy and absorb the $40 million that we have available.

And I just want to make one point on that. You can't look at the establishment of a supercomputer as a 1-year kind of activity. It's a continuing kind of activity. Supercomputer technology, is progressing very rapidly and you've got to upgrade these centers every so often, very frequently, in fact. So what we are taking on by committing to these centers is an obligation for many years to come. So it's not just the $40 million this year; it's the $45 million next year and in 1987, 1988, and 1989, and so forth.

Mr. WIRTH. Do you know about the issue of allocation of time from the supercomputer centers from which NSF buys time? Do you know about the size and scope of that issue?

Mr. BLOCH. Yes, we can talk about that.

Mr. WIRTH. The issue that has come to our attention is that there are many, many more hours that are allocated than hours that are used.

Mr. BLOCH. Well, yes. If you take a snapshot in time right now, that is absolutely correct. In fact, I just had a discussion with an advisory committee on exactly that point. You should realize that it takes time—and everybody will tell you that who has been in that particular field—for a machine to get filled up. Now, we're not talking about a machine here, we're talking about hours. People who have to get on the machine have to prepare themselves; the access to the machine has to be the right access, and many times there are problems in doing so; the experience of the individual investigator who wants to use the machine, he has to become more experienced with it; and so forth. So usually what you will see is a slow increase in the use of time, and then a very rapid filling of that particular capacity. I think we are in a learning curve, at the beginning of the learning curve. And it bothers me, but it doesn't disturb me greatly, that the time is not being utilized today that we think should be utilized today. But I believe that if we keep the focus on it, that in the 3 or 4 months time period we will see that the time is being utilized and utilized very effectively.

Mr. WIRTH. Well, the use of time this year is about 10 percent of the available time it has been used.

Mr. BLOCH. That's about right.

Mr. WIRTH. Is that what you expected it was going to be, about?

Mr. BLOCH. Well, I think that with hindsight we should have expected that, and probably shaped the curve of availability a little bit differently than we did. But that's hindsight.

Mr. WIRTH. Let me ask you a related question which goes to the appropriate mechanism of peer review, but may be discriminating against younger academics, younger scientists who have, perhaps, more unusual nonconventional uses for supercomputers. The argument has been made and come over the transom into our office from a variety of sources that the underusage of supercomputer time is partially attributable to the fact that the structure of the allocation of that time tends to reward more conventional science rather than less conventional science. Is there any truth to that?

Mr. BLOCH. I doubt it.

Mr. WIRTH. I see a shaking of heads behind you, saying "absolutely not." They are probably allocating the time back there. [Laughter.]

Now they're nodding, for the record.

Mr. BLOCH. I would doubt that, Mr. Wirth, that that is true. In fact, let me tell you, we are very conscious—not just of the problem that you are citing, but also of another problem. It's very easy to allocate the time to people that are very experienced in the use of the supercomputers. And except for the buildup curve, I think you can fill up the time, double the time that we have available. And we are very conscious of the fact that one of the roles that we have to play is to bring people into the use of supercomputers that have no experience. And as a consequence, we are allocating time in a very unstructured kind of a way, much more unstructured than we usually do things in the National Science Foundation, to people who want to try out the new tool. So we are very, very conscious of that, and I am also very conscious of what you are saying. I doubt very much that somebody with a very unusual kind of requirement is precluded from using it just because it's an unusual requirement. But we always are conscious that we have a balanced peer review group that is looking at the applications. And I think that in this particular case, we had a very balanced group. It's not just the academics, but also people from the national laboratories that have experience with supercomputers, and also people from industry have been participating in the peer review system.

Mr. WIRTH. As you well know, there is always—when you have an establishment or you have a few people who have a corner on a market, whether it's Members of Congress who have a corner on their districts, don't want to let anyone else in, or academics who have a corner on a particular operation—others have to be on the outside challenging them and making sure that the allocation is done and that the new starters are getting—maybe not equal time, but getting a very adequate shot at the use of that time.

And that's the concern that we have received from a variety of individuals and institutions.

Mr. BLOCH. Well, I am very conscious of that and concerned about it and make sure that it doesn't happen.

And by the way, if you can give me any individuals' names that would like to contact me, I'd be glad to take a look at their particular case.

Mr. WIRTH. Fine. We shall do so.

If I can ask a final question, Mr. Chairman, related to the different kinds of centers which are made available for supercomputing.

You are going to establish a group of new centers, and you currently have some procurement centers. Is it more cost effective to establish the new centers rather than to build up the current procurement centers?

Mr. BLOCH. I think it's more cost effective to establish centers because we are paying very high prices for buying time. Buying time is not a cheap proposition. That's point No. 1.

Point No. 2 that I want to make is the following. It's also important to establish self-contained supercomputer centers that are dedicated to the science community, with the idea of updating these centers, keeping them on the front edge of this particular technology, which is not always the case when you buy time from somebody. And also, when you buy time from somebody you are at the mercy of his own requirements, which changes all the time also.

Mr. WIRTH. But it is efficient for the taxpayer dollar to put the money into the new center and continue to upgrade that rather than to put the money into an area where you're buying time?

Mr. BLOCH. Correct. Yes.

Let me make one more point on that. Many of the proposals—in fact, most of the proposals—have a very high degree of cost sharing included; cost sharing with industry, many times, a cheaper price for the computer itself, support and software, and so forth, and also cost sharing from the rest of the institutions and cost sharing from the State. So the Federal Government doesn't pay the full freight of establishing a center. And that was one of our selection criteria, by the way, how much leveraging is being done in each center by the dollars that the Federal Government puts in there.

So we're not paying the full freight of these centers.

Mr. WIRTH. Mr. Chairman, I thank you very much; and Mr. Bloch, I thank you. You should realize, I think, that a very large majority of Members of Congress are strong, strong supporters of the National Science Foundation as was pointed out yesterday. That pendulum has swung from a lot of skepticism that existed for a lot of the wrong reasons in the mid- to late-1970's, and you're aware of that. And we look forward to working with you. Please remember that there is that kind of support up here and we would like to see as strong a group of advocates on behalf of science at the NSF as possible. If you can't get around David Stockman, come up here in the middle of the night, slip an envelope through the door or over the transom, whatever is appropriate. [Laughter.]

Thank you.

Mr. BLOCH. Thank you very much.

Mr. WALGREN. Thank you, Mr. Wirth.

Mr. Bloch, I'd like to just underscore or underline a couple of points that have been of particular interest to the committee in the past.

One is the request of the National Science Foundation to start to get involved in Japanese literature translation and the access of our scientific community to technological literature abroad. There was previously called for a report, some look by NSF as to what our capabilities to access Japanese literature in the Japanese language are. Can you tell me anything about whether we're making progress on that report?

Mr. BLOCH. First of all, yes, there was a meeting convened to look at that particular area, and we can supply you in a short time with some of the conclusions of that meeting. Are we making progress in total? That's a different question. Let me put it in perspective from my own experience.

Access to the Japanese literature comes in a couple of ways. First of all, Japanese authors are publishing to a very broad extent in foreign journals—not only American journals, but European journals—but there is always, obviously, some articles which are not being translated and not being published in easily accessible journals like French, English, German, and so forth. How much of that is—that's a debatable point, by the way, and a lot of people have tried to get a focus on that; it's very difficult to get a focus on, and I wouldn't want to draw any conclusion. I don't believe it's a very big amount of information that is not easily accessible.

Now, you should also know that the accessibility of that information has a time delay built in because of the publication cycle in many of these journals. But I believe there is nothing that can take the place of an onsite kind of experience in the Japanese environment; and therefore, people going over there is probably more important—or equally important, let me put it that way, maybe even more important—than translating Japanese journals. I think that a lot of companies are doing that on their own; the National Science Foundation has an office in Japan which I think helps us in that regard, focusing on where the information is and helping to identify information. But it's a very, very big problem, and I'm not convinced that the National Science Foundation can solve it on its own.

Mr. WALGREN. I'm not convinced the National Science Foundation should feel the responsibility for solving the problem on its own, but you should know that that is an ongoing interest of this committee, and we are looking for that report, some summary of your assessment of the problem and your perspectives about what you are able to do about the problem in the National Science Foundation. We did have substantial evidence last year that we are not scratching the surface in that area, that our own exposure in our undergraduate and language teaching programs is miniscule, literally, probably countable on two hands, perhaps, the number of people that are involved in it. The Bureau of Standards, essentially, had one man in Tokyo and that was about the extent of it.

So I just want to emphasize the committee's interest in that.

I also want to underscore the interest of the committee in the Arctic Research Commission, and the coordinating role that NSF is to play in assessing the research that's done in the Arctic. The President, as I understand, has recently appointed the Commission; NSF has the lead role in that, and we don't want that to not be given real attention by NSF at this point.

Mr. BLOCH. Well, let me comment on that. The President has not appointed, to the best of my knowledge—or maybe he did yesterday—the members for that Commission, but it's imminent. I'm a member of it also, as you know. We have taken action before everything was put in place to make sure that some work is going on, is started up, in order to support that Commission, and support the work. So we have assigned, out of our own 1985 funds, some funding for that Commission prior to its establishment so that some work can go on, assigned a couple people to it, and the responsibility is clearly defined within the Foundation.

Mr. WALGREN. Well, I would appreciate it if you would keep us as a committee informed of those developments because we feel that NSF can make a real contribution there and we're focused on it.

Also, with the gradual attenuation, if that's the word—of the STIA Directorate, the prospects for focused attention on women and minorities and international programs seems to some of us to be at risk. It has been underscored how important the encouragement we can give to women and minorities is, inasmuch as they will be a majority of our science pool, probably 20 years out, and there is concern that as you line them into the other directorates, it's like block granting other programs to the States and then cutting their funding. It's a way of having something end without being responsible for its ending.

I would like to ask Dr. Schmitt whether or not you can assure us that the Board is very focused on what's happening in that area and is taking some specific steps to assure the strengthening of participation of women and minorities and also, the NSF's general function in the international area. Those are the things that I think are at risk, and I am afraid that without specific addressing and focus on the Board that we might lose something very valuable. Would you like to comment on that?

Dr. SCHMITT. Yes, I would like to comment on that. I assure you that we appreciate and fully support your concern for women and minorities. As a matter of fact, one of the theories of the case in forming the new Education and Human Resources Committee was that putting the issue of women and minorities and handicapped into the larger context of human resources would provide a better basis for addressing that, perhaps, than having it specialized as it previously was as a separate committee.

We had a discussion of that, as a matter of fact, this morning and everyone concerned agrees on the high priority of addressing that issue and continuing to pay attention to it. That is one of the explicit charges of this Committee on Education and Human Resources.

In the international area we have a Committee on International Science under the chairmanship of Dr. Nierenberg, Director of the Scripps Institute of Oceanography, that is attempting to define and come to grips with the role of the Board and the Foundation in international science activities.

Mr. BLOCH. Can I comment on the same subject?

First of all, the targeted grant programs that you focused on, which are being administered out of STIA, are still administered out of STIA. They are not changed in terms of the total dollars involved; in fact, one of them, namely, the research support for women, has been increased in the 1986 budget.

Second, on this same subject, by putting the focus and the responsibility on the rest of the organization, that's very important in order to do essentially the mainlining that I think would be the right answer in the long haul. So we are not dismantling the targeted programs. They are in place, one with an increase. STIA has the oversight over it. But the rest of the Foundation has to carry some of the responsibilities for it, and only that way can we mainstream some of these programs.

With regard to international, I think if you look at the total budget in 1986 we are spending more money in 1986 on the international programs in total than we did in 1985, about $5 million more. It's true that the program in STIA, which was essentially bilateral primarily, has been decreased by $1 million. But I think the difference is made up by the fact that we have the focus in the other Directorates on international programs.

The second point I want to make on international programs, we are looking under Dr. Guy Stever's direction right now—I have asked him to head up a task force and it's in the middle of doing its work right now—to really point out and really investigate what the role of the National Science Foundation in international science should be in the future, and how best we can implement that. When that one is done we will come back to you and give you a review of that and I think the reason why this is a timely kind of an area, because international science is increasing in its content and in its value to us. The demise of UNESCO, I think, is putting a slightly different focus on international science, that's the second reason—I mean, the demise of our participation in UNESCO is putting a focus on it—and third, we have been doing very well with bilateral international programs. But I think we might need to change the approach that we are using, and also enlarging international programs in a more comprehensive way than just doing what we have been doing well in the past. And that's why we are taking a completely fresh look at the international——

Mr. WALGREN. Well, I just want you to know that we are very concerned about that and would encourage you in that direction.

You mentioned earlier that the instrumentation problem was a moving target and one that we're going to have to be giving attention to over the years. Where are we on assessing the size of these problems? And I'm thinking particularly of the facilities assessment, which apparently was hung up someplace in OMB. How directly is the National Science Foundation going to be causing assessments of the size of both instrumentation needs and facilities needs to be made?

Mr. BLOCH. Well, I mentioned in the hearings last week or two weeks ago, in the full committee, that there is in progress an NSF-sponsored look at the indicators—for instance, where we stand with regard to instrumentation in the universities—and that will be finished sometime this year, the third quarter of this year. So that will be a look at instrumentation.

By the way, the last couple of years we have looked at instrumentation in the narrow sense, in certain discipline areas, from time to time also. So we're not completely flying blind.

With regard to the facilities area, right now there is no active approach to that total question. What I'm waiting for, myself, is some of the work that is going on under OSTP guidance in the Packard Bromley Committee that is addressing that particular problem. Depending on what comes out of that one, we want to take another look and see what the National Science Foundation can do in terms of the facilities question by putting more emphasis on it or trying to find out more what goes on, but we don't have a firm plan right now. We don't have a plan right now.

Mr. WALGREN. I'm sorry—you don't have a firm plan at this point?

Mr. BLOCH. To do something in terms of facilities, like making a survey, or what have you.

Mr. WALGREN. All right.

Dr. SCHMITT. Well, we have a small initiative, as a matter of fact, to try to associate with some of the new programs whereby the

Foundation will accept proposals for funding of renovation of facilities, for example, in connection with the engineering——

Mr. WALGREN. How small is that program?

Dr. SCHMITT. Well, it isn't the precise size of it that is specified. I say it is small because it has to fall within the funding for the engineering research centers and the biotechnology initiative, for example.

Mr. WALGREN. I see.

Dr. SCHMITT. But the theory of the case there was that by approaching it that way it should give us some additional indication of what the magnitude of the problem is and give us a little experience in seeing how it might be approached.

Mr. WALGREN. Is that the best way to find out the magnitude of the problem?

Dr. SCHMITT. Well, it is one way. I don't pretend that it is the best way; I presume that some broad study could be instituted to find out——

Mr. WALGREN. But you have no plans for that at this point?

Dr. SCHMITT. Not at this point; no.

Mr. WALGREN. OK.

Then let me just ask one other question, and that is, looking at the charts that you distributed, one of the things that really stands out is the dramatic resurgence in science education on the pre-college level. You're down to almost nothing in 1983 from participation of maybe 15 percent in the whole program prior to that reassessment; and then it explodes from zero to over 50 percent of the program. Now, I gather the reason for that is that we do want to address precollege; we feel that there's some leverage there, and that's a good thing. But that certainly would not explain such a dramatic shift in the percentage of focus of dollars spent in that area. What would be the other explanations for such an immediate resurgence of precollege expenditures compared to other programs?

Mr. BLOCH. Well, I wasn't here in 1983 and 1984 but what I think it was was a realization that you cannot spend the limited dollars that NSF will always have for this particular area compared to the total problem, and satisfy everything and everybody. And therefore some concentration had to take place. And the area of concentration that was picked was essentially precollege education as being a very important subject. You could have picked undergraduate education also, for instance. But that wasn't done. And I think the decision was right, that we focus on precollege education because that's where the problem starts that we have, if you don't get enough scientists or well-prepared scientists or engineers into the colleges. So it was essentially a rational decision that not everything can be done by the National Science Foundation, that the dollars earmarked have to be concentrated in order to be effective, and the precollege education area being one of the very important ones. The other one was the instrumentation, and obviously the fellowships—and the fellowships have always been very high on the Foundation's agenda.

Mr. WALGREN. Well, it seems that whatever was ranked in the other support was not competing very well against whatever was ranked in the precollege support. My own instinct is that a decision to concentrate on precollege would explain an increase of some percentage participation, but I've never seen the programs change so dramatically as that in terms of the focus on one area to the exclusion of others. That is a very, very dramatic shift. I'd be curious whether there are any other explanations for it, other than a rational decisions to do precollege.

Mr. BLOCH. Well, the only other thing I can say about the pre-1982 "other support" area which you have in front of you is that this consisted of many small programs, and some of them not so small programs—about 20-25 programs—that were all under this one area called "other support." And the point I tried to make before is, with our very limited kind of dollars that we have for this particular area, and that we'll always have for this area, I think it's very important that we concentrate on those things that have highest possible leverage and where the need is the greatest. And the precollege education area is where we would want it.

Mr. WALGREN. Well, I think that point is intact, and as the lawyers say, that would be a good argument. But you certainly would not look at that distribution and say that the science education resurgence is presently balanced. And when you see the other support going from what looks to be 60 percent down to what must be no more than 10 percent, I would question whether that's a balanced resurgence of that program, and I would hope that the people responsible for that program would note the same thing, and be on the lookout for causes of that kind of distribution that may not be in the best interests of the country.

Mr. RITTER. Will the gentleman yield on that?

Mr. WALGREN. I'd be happy to yield.

Mr. RITTER. I am not quite sure what the gentleman is saying when he says that this distribution might not be in the best interests of the country. Now, I'm no expert in figuring out this graph and the gentleman probably knows more about what happened to the blue area than I do, but it seems that that rose-colored area in precollege education has got to be fundamental and if you've got a limited amount of money and you're just going to try to leverage it, given the problems that we alluded to before within this system, we have structural problems within the system in terms of responding to some of these demands—that it would be natural. Now, if the gentleman could educate myself and the record as to what is the problem there, other than they have focused, but why would it be a problem if they have so focused? There may be some good reasons.

Mr. WALGREN. Well, I can't say that there aren't good reasons. All I can point to is radical change in the distribution of those moneys. If, for example, one of the reasons for that radical change is, as the Director suggests, those were small grants, that is not a reason that goes to the merit of the grant or the merit of the contribution that that grant was making. And it may very well be that in this kind of a change, some things fall out or do not compete not because of their merits, but because of their structure or their size or something like that. And the only point I want to make is, I want to call very much to your attention that when you look at that graph you can see an area that is falling substantially behind, where there is radical movement away from one area and a dramatic increase in another area, and it would be a fair statement that that is not a balanced distribution. Now, there are reasons not to have balance; but as I say, there is balance, and there is balance, and this may not be the one we feel should be struck.

I only want to call that to your attention so that your own system examines that as best you possibly can.

Dr. SCHMITT. If I could comment, we appreciate your comments and can certainly do that.

But just to reinforce the reasons for the concentration on precollege education, the National Science Board's own Commission on Precollege Education in Mathematics, Science, and Technology, plus other studies—the Carnegie Foundation study several years ago—all focused on that area. So I think it's quite natural for the foundation and our programs, for the reasons that Mr. Ritter gave, to have that perhaps be one of the top priority things to look at at the present time. Whether that's the right long-term balance is a valid point, and I think that we can look at that.

Mr. WALGREN. I really only want to underscore what appears on the graph, and the best function I can perform.

The Chair would have one other thought. In just going through things and sort of emphasizing some things that I hope you will respond to, not today but in your thought process, one is this television potential. Right behind that lies the potential of the museums in their contribution to science education and hands-on physical experience of children. And I would hope that you not only look at—when you are expending all the money under science education—that you not only look to the television side, but also weigh very carefully what you feel is in the best interests to do with encouragement that can be given to museums that have a wonderful contribution to make.

Dr. SCHMITT. OK. Very good.

Mr. WALGREN. Well, with that let me turn to my colleague from Pennsylvania for anything further.

Mr. RITTER. I have nothing further.

Mr. WALGREN. Well, on behalf of the committee, thank you both for coming. We appreciate your participation in this and we think something good comes out of it, and we will pursue you to the ends of the Earth to make that happen. [Laughter.]

So, thank you very much.

[Whereupon, at 12:53 p.m., the subcommittee recessed, to reconvene at the call of the Chair.]

APPENDIX I

Follow-Up Questions for NSF
and Answers

1. Ethics and Values in Science and Technology (EVIST)

Question: What was your rationale for terminating the EVIST program? Was the National Science Board or the EVIST advisory committee consulted prior to the decision to terminate the program?

If Congress decided to restore $1.0 million for EVIST in FY 1986, what program would you recommend for reprogramming to make those funds available?

In your testimony before the Committee, you noted that "Much of the work that it has accomplished and that it is doing is being taken over by the other people; it has a life of its own. Some of the journals that were started are today self supporting kinds of journals in this particular area of Ethics and Values in Science and Technology ... no reflection on the work ..., but I think a lot of it is stand-alone." Please provide evidence to support these comments as well as which professional and scientific societies are taking up issues EVIST covered in the past.

Answer: In reviewing the base programs of the NSF for potential reductions for FY 1986, EVIST, as well as several other programs, was identified as being of lesser priority in a year of budget austerity. The EVIST program has been in existence as a separate program element since FY 1976 (in addition, several small projects were funded in FY 1974 and FY 1975) and has been effective in raising consciousness of the importance of ethical and value issues in science and technology. It has supported several projects which are now self-supporting, i.e., the Journal of Science, Technology and Human Values (jointly supported by Harvard, MIT, and John Wiley publishers), and has been instrumental in stimulating professional societies to take a more active role in the ethics and values area.

The concept of the program has been demonstrated and in my view, there is no longer a need for EVIST as a separate program. Fundamental research topics in ethics and values are eligible to compete in other areas of the Foundation, particularly in the Social and Economic Sciences program.

In January 1985, the decision to terminate the EVIST program was discussed with the National Science Board. The EVIST Advisory Committee was not consulted.

If $1.0 million were earmarked for the EVIST program in FY 1986, the Social and Economic Sciences program would be reduced by that amount.

The testimony referred in particular to the Journal of Science, Technology and Human Values. The Journal began as the Newsletter of the Program on Public Conceptions of Science in the early 1970's. It was edited and published through the Jefferson Physical Laboratory at Harvard University, supported by grants from the NSF Office of the Public Understanding of Science and the Commonwealth Fund. The EVIST program made an award to the Newsletter in 1973-74 to compile a directory of EVIST-type activities around the country. EVIST and the Science, Technology and Human Values program at the National Endowment for the Humanities made a joint award to the Newsletter in 1976; and the Endowment continued to support the magazine, renamed Science, Technology and Human Values, after a joint review the following year.

Many professional societies have standing committees that have incorporated the results of EVIST-supported research in their activities to monitor and evaluate matters of professional conduct and standards. Increased attention to and interest in ethical and value issues can be seen in the recent development of the Professional Society Ethics Group. Coordinated by AAAS through the office of the Committee on Scientific Freedom and Responsibility, the Group currently has 26 members from AAAS affiliates and meets twice yearly in DC to discuss programs initiated by professional groups in response to contemporary issues involving ethics, science, and technology. Members include many of the well-known societies in the natural and physical sciences, mathematics, engineering, and the social sciences. At the October 17, 1984 meeting, representatives from the American College of Physicians and the American Psychological Association described the activities of their associations. At the March 6, 1985 meeting, Sigma Xi discussed its report "Honor in Science;" the National Society of Professional Engineers reported on a whistleblowing case, and a representative from the FTC described its policies and procedures vis-a-vis anti-trust and the professions.

Private foundations are also demonstrating an increased interest in supporting EVIST-type studies and other projects. The Robert Wood Johnson and Kellog Foundations have supported work on health-related issues in particular. Exxon Educational Foundation has supported studies and curriculum development on technological issues; and Exxon and Sloan Foundation (as well as EVIST) are contributing to the Student Pugwash Conference on Science, Technology, and Individual Responsibility this summer.

2. Role of NSF in International Science

Question: What do you feel the role of NSF should be in representing U.S. interests in the international arena?

Answer: The main role of NSF's international activities is to strengthen the U.S. research effort in science and engineering through the support of a range of activities, including the following:

- cooperative research carried out through formal bilateral and multilateral agreements and institutions;
- cooperative research carried out by informal means, that is, through an international dimension of domestically supported research; and,
- major multinational cooperative research projects, notably the Antarctic program and the Ocean Drilling program.

Virtually all Federal agencies participate to some degree in international cooperative science and engineering activities. In addition, the National Academy of Sciences, the National Academy of Engineering, and the National

Institute of Medicine are active in the international arena. And, of course, there are innumerable institutions and individuals directly involved in international science and engineering. NSF supports many of these activities when they are judged to be of high quality and in the best interest of U.S. science and engineering.

Question: How well do you think NSF fulfills that role?

Answer: NSF believes that, within the resources available, it fulfills its role well. With the growing importance of science and international affairs, NSF also believes it is now appropriate to assume a more active leadership role in supporting those aspects of international scientific cooperation that bear directly on the health of U.S. science. To that end, the Foundation is considering ways to strengthen its international policy and analytical capabilities.

Question: Will the role of NSF change now that the U.S. has withdrawn from the International Institute for Applied Systems Analysis (IIASA) and UNESCO?

Answer: No. In regard to IIASA, NSF will consider project support on a case-by-case basis, pursuant to the Department of State (DOS) instructions. The U.S. science sector aspects of the UNESCO situation are the responsibility of DOS.

3. Antarctic Program

Question: What role is NSF playing in the upcoming 1991 review of the Antarctic Treaty? What activities does NSF have in place, or plan to implement, to insure that scientific research will continue to be the major component of the Antarctic Treaty?

Answer: The Treaty has been reviewed by the Consultative Members twelve times since 1961 and continues to evolve at formal meetings at about two-year intervals. The Thirteenth Consultative Meeting will convene in Belgium this fall. The NSF provides advice to the Department of State on selected agenda items, proposed U.S. positions, and instructions to the U.S. delegation to those Treaty meetings; the NSF usually supplies an adviser to serve on these delegations.

While the Treaty provides that a Consultative Member could call for a Conference of all Treaty members (to include the non-Consultative Members) after 30 years (in 1991), this might well not occur. The non-Consultative Members already have been invited to participate in the regular review meetings and in the Special Consultative Meeting on non-living resources subsequent to the eleventh meeting held in 1981. Should a special Conference be called, the NSF role would be essentially the same as its present role in the regular Consultative Meetings.

NSF has maintained the position that a strong, well-balanced program of scientific research, and the generous sharing of research results, is the most effective means of sustaining U.S. leadership in and influence over the evolution of the Antarctic Treaty System. This position has held through a half-dozen comprehensive reviews of national policy and has been formally enunciated most recently by White House memorandum #6646, dated February 5, 1982. Further, the NSF has solicited and obtained from the National Research Council, National Academy of Sciences, a study and recommendations concerning program scope and content. This report, Research Emphases for the U.S. Antarctic Program, published in 1983, has been distributed within the U.S. and abroad. NSF maintains regular contact with the Antarctic Program Offices of other nations to promote cooperative research projects and the exchange of scientific personnel. On average, about 10% of the scientists involved in U.S. Antarctic Program field activities are foreign nationals. Finally, use of NSF's peer review system to select from competing proposals those of most scientific merit enhances the quality and credibility of the U.S. program.

While these clear expressions of U.S. policy, scientific program and commitment do not insure that other Treaty nations will follow, they do provide clear leadership and stimulus for continuing scientific cooperation that benefits all. NSF will continue these efforts to influence Treaty emphasis on scientific research through enthusiastic support of the international scientific community.

4. Presidential Young Investigator Awards

Question: How would you evaluate the effectiveness of the Presidential Young Investigator (PYI) Awards in accomplishing the intended goals of the program?

Answer: Since the first group of PYI awardees is still only midway in the first year of a five-year project, measures of the effectiveness of the awards can only be tentative at this time. However, an indication of trends can be based on:

1) The response of universities as measured by nominations has been overwhelming. The number of nominations in the two years to date has been 1,549 for FY 1984 and 1,089 for FY 1985 with only 200 awards available each year. The decrease in the second year was almost entirely due to a major restriction of eligibility.

2) The response of awardees has been characterized by favorable comments on the flexibility to be able to carry on unusual research for which standard support opportunities have been frequently lacking.

3) The response of industry has been sustained and growing (see next Question).

These measures indicate a high degree of program effectiveness at this point.

Question: Has industry met its anticipated commitment to the program?

Answer: As of late February 1985 industry's participation in terms of matching funds provided to support the work of awardees had reached 68% of the maximum, with about 2 months left before NSF's deadline. Considering the diversity of fields represented by awardees, we feel industry has made a good start on demonstrating a long-range commitment to the program.

Question: How do you plan to stimulate industry participation?

Answer: The Foundation is continuing to expand its communications with industry. We have been in close consultation with appropriate industry consortia and associations. This year for the first time a detailed brochure will be prepared containing the specific research interests of all new awardees.

On November 19, 1984, the Foundation hosted a meeting of Presidential Young Investigators (PYI's) and academic and industry representatives to analyze the first year of program operations. The meeting was very beneficial, particularly in discussions of how the PYI's might obtain matching funds.

Question: Do you feel benefits could be realized by extending the PYI Awards to undergraduate institutions?

Answer: The objective of the PYI program is to improve the capability of universities to provide post-graduate training of the scientific and engineering personnel needed for academic and industrial research in the future. This objective mitigates against the participation of undergraduate institutions in the PYI program. However, NSF does support other programs that emphasize faculty research at predominantly undergraduate institutions. These include Research in Undergraduate Institutions, which specifically targets non-doctoral institutions and departments, and Research Opportunity Awards, which permit faculty members from undergraduate institutions to participate in research at major research institutions.

5. Balance between Individual Grants, Research Centers, and National Laboratories

Question: What mechanisms does NSF use to assure a balance of funds allocated for individual grants, interdisciplinary research centers, and national laboratories? How would you define an "appropriate balance" for these various means of funding research?

Answer: The balance between types of support is closely monitored, both annually and as part of NSF's long-range planning process. Balancing support between these mechanisms is a dynamic process, requiring close examination of both trends over time (including disciplinary differences) and emerging research opportunities. Participating in this monitoring process, in addition to the NSF staff, are the National Science Board, advisory committees, special study panels, and the scientific community at large.

The core of NSF support has been, and in all likelihood will continue to be, the individual research grant. Over the past few years this has changed somewhat in Engineering and Materials Research, for example, in that a larger proportion of funds for these disciplines are being allocated to group research projects reflecting the growing complexity and interdisciplinary nature of research problems in these areas.

Support for large-scale projects, mainly facilities such as telescopes, accelerators, and the like, has remained essentially stable at about 17% of the NSF research budget over the past four years.

In addressing the issue of "appropriate balance" among individual grants, interdisciplinary research centers, and national laboratories, the Foundation must examine how each of these support modes contributes to the health of U.S. science and engineering. Clearly support is required for each of these research modes, but the appropriate balance changes as research opportunities and needs change.

6. Information Science

Question: What is your view of the importance of information science research?

Answer: We regard information science research as an important basic research area with a substantial applied potential. The Information Science activity at NSF is a unique interdisciplinary set of programs that cover a broad range of research problems. It complements other computer and information technology programs and bridges a gap between these and several behavioral and social science disciplines.

Question: How do you view the adequacy of the NSF funding levels for information science over the past five years, and in the FY 1986 request?

Answer: After several years of a careful planning and structuring of the Division's activities so as to achieve a quality research activity that is fully coordinated with related activities supported by other NSF divisions and other Federal agencies, the Information Science Division is in an excellent position to expand its activities by nearly 50% in FY 1985, followed by a proposed increment of 6.8% in FY 1986. Taken together, these increases will substantially improve the IST resource base.

7. Mathematics Research

Question: To what degree will the proposed increase of 15% for mathematical science address the recommendations of the National Academy of Sciences report, "Renewing U.S. Mathematics: Critical Resource for the Future"?

Answer: "Renewing U.S. Mathematics" recommended that Federal funding for the mathematical sciences be more than doubled. Specifically, it recommended increases of 18% in constant dollars for each of five consecutive years. The proposed increase of 15% is a start in that direction within the realities of the current budgetary situation. The increase will be used to provide support for graduate students and young investigators, and to provide funds for computational equipment and access to computational facilities.

Question: What other Federal agencies fund mathematics research?

Answer: About 95% of the Federal funding for research in the mathematical sciences comes from the combined funding of NSF, the Department of Defense, and the Department of Energy. The rest comes primarily from the National Aeronautics and Space Administration, the National Institutes of Health, and the National Security Agency. In FY 1984, the Foundation provided about 60% of the Federal support for mathematical research at academic institutions. This breaks down into 28% of the support in applied mathematics, 43% in statistics and probability, and 99% in the areas of pure mathematics.

8. Scientific, Technological, and International Affairs (STIA)

Question: What are the rationale and long-term implications for the change in management and funding of programs in STIA?

Do you plan to phase-out STIA in future years?

Do you plan to establish an international unit in NSF to place a central focus on international science and research needs?

Answer: In order to make the programs in STIA more effective, that address special issues in science, such as the underrepresentation of minorities, women and the physically disabled in science, there must be a close coupling with the disciplinary research programs of the Foundation. Researchers who receive their initial support through one of the sheltered programs must seek continuation support through the disciplinary programs. Without early involvement with these programs, successful transition is much less likely. The STIA staff will still be very involved in these mainstreaming efforts. They will provide assistance to the disciplinary programs and provide a monitoring capability for the Foundation as a whole.

There are no plans to phase-out STIA. The role of STIA is undergoing reexamination and redefinition but there is no intention to abolish STIA as an organizational entity at this time.

The international activities of the Foundation have just undergone review by a Task Force on NSF International Strategy and Programs chaired by H. Guyford Stever, a former Director of the NSF and currently the Foreign Secretary for the National Academy of Engineering. This Task Force was asked specifically to address the question of the proper organizational status and placement of international activities. I have met with them several times during their deliberations and over the next few months will be exploring options for implementing their recommendations.

9. Priority Setting

Question: What are NSF's long-range plans (number and level of support) for the Engineering Research Centers? How many Centers do you plan to have in operation 10 years from now? How do you determine priorities for funding Centers vs. individual grants for fundamental engineering research?

Answer: The NAE report, "Guidelines for Engineering Research Centers," states "...they must also be of sufficient scale to make a noticeable impact on the overall content of Engineering. Accordingly, it is concluded that a target of 25 Centers should be established for the overall programs..." The number of Centers 10 years from now depends on a number of factors, including the availability of funds and the degree of industrial support. Equally important is the relative balance between the support for individual grants and for Centers. The Foundation feels that it is important to maintain a healthy individual engineering-grants program not subsumed by the Engineering Research Center activity. Strong individual research grants programs, together with the opportunities for cross-disciplinary research provided by the Centers, are required to ensure the health of engineering education and research.

Question: What is the status of the FY 1985 funding for the Engineering Research Centers and when will their selection be announced?

Answer: We expect to obligate $10,000,000 to the Engineering Research Centers in FY 1985. Present plans call for announcing the selected centers in early April.

10. Priority Setting

Question: The FY 1986 NSF budget strategy included the maintenance of an "appropriate balance across fields and types of projects." How would you define "appropriate balance" and how are priorities set to achieve such a balance?

To what degree does NSF set their priorities in relationship to priorities of other R&D agencies?

As Director of NSF, have you participated in FY 1986 R&D priority setting with other agency heads?

Answer: The concept of "appropriate balance" is a dynamic one which is reflective of trends over time, different disciplinary needs, and scientific opportunities. Priorities for allocating competing funds among these areas are established through an interactive process involving the NSF staff, the National Science Board, external advisory committees, special study panels, the scientific community, and other government agencies, particularly the Office of Management and Budget and the Office of Science and Technology Policy.

Discussions of priorities across agencies are facilitated by the OMB and OSTP. One formal result of these priority-setting discussions is the establishment of formal Memoranda of Understandings (MOU's) or Interagency Agreements. Examples of these are found in the Continental Lithosphere Program, the Earthquake Hazard Mitigation Program, and the NASA-NSF agreement with regard to use of the Space Telescope. There is in addition a great deal of informal interaction between the working level staffs of the science agencies, so that relative priorities at other agencies are generally known. These do, of course, get fed into the priority-setting process of the Foundation.

As Director of NSF, I have met with other agency heads from time to time. These have been general information sharing meetings rather than formal priority setting sessions. Information from these meetings, however, has been considered as NSF made choices among competing options.

11. NSF Management

Question: The NSF budget has increased by over 50% in the past five years, yet staffing has dropped from 1,293 in FY 1981 to 1,172 in FY 1986. What impact has this reduction in staff had on the quality of proposal review and management within NSF? What concerns do you have about this decline and, if Congress were to provide some relief, what areas would receive priority treatment?

What is your assessment of the Foundation's Management Information System?

What long-range planning mechanisms does NSF use to estimate future resource needs?

Answer: We have been able, up to this point, to maintain our standards for proposal review and management by taking steps to improve the productivity of our staff. In particular, we have greatly expanded the use of personal computers. We will need to continue instituting productivity improvements. This past summer I appointed an internal task force to study bureaucracy and control at the Foundation and to make recommendations to me. This has been done, a report has been issued and discussed with Assistant Directors and other staff, and work has begun on implementation. In response to this report, we are taking steps to reduce paperwork wherever possible, and we have reduced the number of signoffs required for routine approvals.

The staff level is now at a bare bones level throughout the Foundation. If it were possible to obtain some relief with regard to the personnel numbers, my first priority would be to augment the staffing level in the research programs. I am committed to holding the line on the staffing levels in the Administration Directorate and the staff offices. I should also point out that, if additional programmatic responsibilities are added or if some current activities are significantly expanded, then corresponding additions will be absolutely necessary in staffing and PD&M as a whole. Our flexibility to absorb additional tasks without additional support resources is stretched to the limit.

The Management Information System at the Foundation is undergoing a much-needed reexamination and upgrading. We have made significant improvements during the past year and we expect more progress in the near future.

1. I have moved the organization unit that is responsible for data systems management from its previous location in the Administration Directorate to my personal staff, to give it both stronger support and to stress its importance both internally and externally.

2. We have recently restructured our MIS Steering Group, and it is moving aggressively to tackle both long range planning and short term problem issues.

3. We conducted a study this past summer to determine our immediate and longer term data needs, present capabilities, and steps necessary to meet long term needs. Since that time an implementation task group has been established, which is working on procedures, forms, and policies necessary to implement the recommendations of this study group.

4. By the end of FY 1985 we will have acquired 300 additional personal computer workstations, which will bring the total to 500 workstations distributed throughout the Foundation. Three hundred more are planned in FY 1986. Already we see positive gains in automating the mechanics of proposal processing, doing more sophisticated data analysis, and generally improving the productivity of both professional and support employees.

With regard to long range planning mechanisms to address future support resource needs, we are working to develop a more systematic approach in this area. In fact, it is my goal for strategic planning in this area to receive the same quality of attention that planning in the disciplinary research areas does. As a start, we have conducted a baseline staffing analysis study. This will enable us to project future personnel resource needs using the model developed and to better understand deviations from the model. We are looking at the impact that expanding automation techniques has on our staffing requirements, both in numbers and professional/support mixes. We are developing mechanisms to project associated staffing, space, travel, and equipment needs to match different staffing levels and mixes. This is a difficult planning area but we are committed to making significant improvements in our ability to develop a strategic outlook.

12. Construction and Management of Large Facilities

Question: The "Aladdin" synchrotron light source project at the University of Wisconsin is plagued with technical and management problems leading to major cost overruns and project delays. What is the status of NSF's effort to resolve the problems?

Answer: There is in progress a detailed technical study of the Aladdin project. This study is being carried out by a team of experts from several DOE laboratories and members of the staff of the Synchrotron Radiation Center of the University of Wisconsin (SRC). The study will assess all technical aspects of the Aladdin project and prepare a plan for the completion of the project. The study has been underway since December 15, 1984. Its final report is due May 1, 1985. In addition, the University of Wisconsin is also preparing a plan for managing SRC and improving its staff; this plan is also due on May 1, 1985.

Question: Do you think it was wise to site such a complex National Facility at a university without a thorough evaluation of that institution's technical and management capabilities?

Answer: At the time the facility was placed at Wisconsin, such a thorough evaluation by technical experts did take place, and it was judged that, indeed, Wisconsin did have the technical and managerial capabilities to build Aladdin and bring it into operation. Their performance in bringing Tantalus into operation and managing it for the benefit of users has been outstanding -- indeed it became the model for how a user facility should serve its constituent community. The basic Aladdin ring has been built. The experts believe it is a storage ring of sound design, which will operate very well. However, in bringing the Aladdin system into operation, a new level of complexity was uncovered, which strained the then existing capabilities at Wisconsin. These problems are now being realistically addressed.

Question: What procedures have you established at NSF to see that we don't repeat the Aladdin experience with other large, complex projects?

Answer: During the course of the construction and commissioning of a large complex facility:

1) Quarterly site visits with experts will take place, in addition to monthly site visits by NSF staff.

2) A management plan will be reviewed and approved before the award is made.

3) Checkpoints are set which will allow for comparing the accomplishments with the schedule. Monthly progress reports are required.

4) Reports to the Office of Budget, Audit, and Control are required.

5) NSF has quarterly reviews with the Director to discuss such major issues.

13. Management of Women and Minorities Programs

Question: A number of programs, among them two having to do with women and minorities, are now to be funded from the discipline-oriented directorates, rather than as line items in the STIA Directorate, where they have been.

Do you think it will be possible to monitor such programs when they are spread over so wide a base?

What kind of requirements are there to help keep track of progress in these programs?

When can we anticipate reports from the NSF Management Information System dealing with the numbers of women, minorities and handicapped in various NSF roles, e.g., grantees or principal investigators, Presidential Young Investigator Award winners, proposal reviewers, rotators?

Answer: The STIA Directorate will continue to play a key role in the monitoring of the Research Opportunities for Women (ROW) and Minority Research Initiation (MRI) programs for which funding responsibility has been shifted to the discipline-oriented directorates. The STIA activities will be carried out in much the same way as the predominantly undergraduate institutions effort, which is coordinated across all of the disciplinary research programs.

There will continue to be a line item shown in STIA for both the ROW and MRI programs. (It will be a non-add item, just as is the support for predominantly undergraduate institutions line item.) There will also continue to be special program announcements for both the Research Opportunities for Women and Minority Research Initiation programs. There will be a program officer in the STIA Directorate whose responsibility it will be to monitor proposals received in response to these announcements from their arrival in the Foundation to the final decision. These program officers will prepare quarterly reports to the Director on all of the Foundation's support for women and minorities.

Targets will be set in each of the directorates for funding floors for MRI and ROW. These will be monitored through the MIS, and status reports will be a part of the quarterly report to the Director referenced above.

Some reports are possible now from the MIS on the participation of minorities, women and the handicapped in NSF programs. At present most depend on information supplied by the proposer at the time of proposal submission. The response from proposers is improving--nearly 50% now send the voluntary data form. In some programs the submission rate is even higher. In the 1985 Presidential Young Investigators competition, for example, more than 70% included the voluntary form with their application materials.

We are continuing to investigate ways to improve our data base through changing the placement of the sequence of forms in the Grants for Scientific and Engineering Research to the issuance of explanatory materials for university development officers, and talking with potential proposers at professional meetings.

We are in the process of developing plans to gather more extensive data on the attributes of proposal reviewers. The challenge here is to develop an approach that does not reduce the reviewer response rate.

Currently, we have extensive information on the rotators who are employed by the Foundation.

14. Facilities and Centers

Question: What is the cost, in the long run, (financial outlays, impact on research, etc.) of stretching out construction of the Very Long Baseline Array and acquisition of computer enhancement for the National Center for Atmospheric Research?

Answer: The long-term cost of stretching out the construction of the Very Long Baseline Array (VLBA) is significant.

Total construction cost in current-year dollars (and in constant 1985 dollars) has increased from the original estimate of $59.2M ($57.5M) for the optimum 3-year schedule (A) to $66.3M ($61.5M) when a 4-year, approximately constant effort, plan (B), was adopted in 1984. The FY 1985 appropriation level of $9.0M and construction start of April 1, 1985, shifted Plan B later in time by several months. The FY 1986 Budget to the Congress with its request of $11.5M for the VLBA construction assumes a 5-year schedule (C) resulting in a total cost now estimated at $70.3M ($63.2M). A constant-effort plan (D) at the FY 1986 requested level would result in a 7-year construction funding schedule and a total cost of $77.6M ($67.5M).

Completion in the sense of full usability of the instrument by the scientific community is delayed from 1988 of the original plan (A) to 1990 in schedule (C) and to 1991 in schedule (D). Partial operation with the ability to acquire some scientifically significant data shifts from 1986 (Plan A) to 1989 (Plan D). Both delays result in serious losses in scientific productivity, in particular, in view of the fact that observations obtained with the NASA Hubble Space Telescope, expected to be launched in 1986, cannot be coordinated with the VLBA in the early years. Finally, the VLBA was supposed to provide the standard for very long baseline interferometry worldwide; a delay in its construction will jeopardize this unique leadership position of the United States.

Stretching out the acquisition of computer enhancement at the National Center for Atmospheric Research (NCAR) is similarly undesirable. The need for a more powerful, faster computing system for NCAR users is immediate. The demand for advanced computing capabilities is continually increasing; the oceanographic community is planning to use 20% of the available NCAR computing time.

The hardware associated with the enhancement of NCAR's computing facilities will cost $25,331,000. NCAR has proposed to finance $18,616,000 of this total by tax exempt bonds over a seven year period. For a probable 10% interest rate, total acquisition cost will be $33,347,000, including $8,016,000 in interest and fees. Financing over a longer period would have two undesirable effects: a higher total cost for acquisition and continued payment for hardware that is likely to be obsolete after the initial seven years of operation.

15. Instrumentation and Equipment

Question: In the past four years, there has been a substantial effort on the part of NSF to upgrade the quality and quantity of instrumentation and equipment at our universities.

How is NSF measuring the success of these investments?

How is the long-term goal/commitment in upgrading instrumentation and equipment and what are universities doing to enhance this effort.

Is there any one discipline in which you believe that instrumentation needs are greater than others?

Foundation-wide; are any funds going to two-year academic institutions to fund instrumentation purchases or upgrades. What is the percentage of total NSF research dollars received by two-year colleges? Which Directorates contribute to this funding?

Answer: Beginning in FY 1984, NSF has targeted support of instrumentation and equipment for significant increases. This trend is continued in the FY 1986 Budget proposal. Our current support, $240 million, in FY 1985 for facilities, equipment and instrumentation is double that of FY 1983, and we propose a further increase in FY 1986 of $31.0 million or 13% above the FY 1985 level.

At the same time as we began to address the problem of insufficient support in this area, we began also to monitor the status of university equipment and instrumentation. The most recent report in December, 1984, focussed on the status of equipment and instrumentation as of 1982 in 43 universities. This documents the status of equipment and instrumentation in the physical and computer sciences and engineering at that time. A parallel study of the status of equipment and instrumentation for the biological and environmental sciences as of 1983, not yet published, has similar conclusions. The effects of the increased support beginning in FY 1984 is not yet apparent in these studies. We plan, however, to continue similar studies on the baseline inventory of equipment and instrumentation in these universities to monitor the effects of recent increased NSF support. Additionally, our next annual survey of Scientific and Engineering Expenditures in Universities and Colleges due this summer, should indicate the general increased Federal support for FY 1984. These studies will enable us to determine whether we have achieved our initial objective of redressing the problems of insufficient and obsolete equipment that have been identified in all disciplines in several studies since 1980.

Our long term commitment is to ensure that modern equipment and instrumentation is available to university researchers. The universities are partners in this commitment. For example, the universities provide substantial cost sharing, including maintenance costs, as a general rule for the purchase of equipment and instrumentation. In the case of our dedicated instrumentation programs, this cost sharing ranges from 30% to 50% of the total cost. Both the universities and NSF have continued to explore with industry the availability of deep discounts for universities on certain equipment purchases.

It would be misleading to single out some areas as having more pressing needs for instrumentation than others, because there are many indications and reports that concerns about the quality of available equipment and instrumentation exist in all disciplines. These are the result of rapid changes in science that lead to requirements for increasingly sophisticated instrumentation and of technolgical innovation in instrumentation development. For example, in recent years, the Biosciences have undergone unprecedented growth in the opportunities to utilize sophisticated instrumentation developed, for the most part, in the physical sciences. The conduct of contemporary research requires equipment such as computerized analytical instruments, video image enhancement instruments, electron microscopes, fluorescence photomicroscopes, cell culture facilities, and spectrophotometers. The costs for basic necessities are high; to equip a beginning investigator's lab in these fields today may cost on the order of $0.25 million. Another example, from the fields of both chemistry and biochemistry, is the increasing importance of very high resolution mass spectroscopy and high resolution nuclear magnetic resonance spectroscopy. Such equipment may cost up to $0.5 million each.

There is currently no special NSF program that targets research funds to two-year colleges. However, in FY 1984, the Foundation provided $605,624 for research support at two-year colleges, from total funding of about $880 million for research conducted at colleges and universities. Of this total, about $101,000 was used for support of research equipment at two-year colleges. NSF directorates contributing to this funding included Mathematical and Physical Sciences; Astronomical, Atmospheric, Earth, and Ocean Sciences; and Biological, Behavioral, and Social Sciences.

16. Productivity Improvement Research

Question: The Productivity Improvement Research Program has served as a successful model for government-wide planning for productive utilization of technology. Given the great need for this type of program, why is it being eliminated in FY 1986?

Answer: In making the difficult decisions about the allocation of limited NSF resources, the highest priority was given to science and engineering research. Therefore, it was necessary to curtail or eliminate a number of programs that were valuable, but deemed to be of lesser priority. Productivity Improvement Research was one such program. However, many NSF programs will continue to contribute, directly or indirectly, to productivity improvement.

17. Handicapped Programs

Question: What is the current status of Bioengineering and Research for the Handicapped (BRH) Program?

Answer: Although Bioengineering and Research for the Handicapped are combined within one program, each maintains its own fiscal and administrative identity.

The budget allocation for the Research for the Handicapped subelement has remained at a viable level as indicated in the figures below:

FY 1983	$2.0M (actual)
FY 1984	$2.3M (actual)
FY 1985	$2.4M (current plan)
FY 1986	$2.5M (requested)

In FY 1984, the Foundation made 46 grant awards for research aimed at advancing scientific and technological development to aid the handicapped. Awards were made in eight categories: communication, implant materials, mobility, independent living, spinal cord injury and regeneration, robotics aids for the handicapped, vision substitution and program planning and program communication.

We plan to continue this level of activity in FY 1985 and FY 1986.

Question: If available, please provide statistics on the participation of handicapped individuals in the research initiation and improvement subactivity programs.

Answer: In FY 1984, less than 1% of the 12,700 principal investigators supported by NSF awards were known to have a physical handicap. For research initiation and improvement, there were no such individuals reported as principal investigators.

18. Earthquake Hazard Mitigation

Question: What do you see as NSF's role in the development of a major national earthquake engineering test facility?

Answer: One of the recommendations of a 1984 report by the National Research Council on the needs and priorities for earthquake engineering facilities and instrumentation was that the Federal government should immediately initiate a conceptual engineering design study of a national earthquake engineering experimental/test facility capable of both dynamically and statically testing full or nearly full-scale multi-story buildings to destruction in a simulated earthquake environment.

The National Bureau of Standards has offered to conduct this study and has discussed this with the Office of Science and Technology Policy. NBS through FEMA has requested that NSF help underwrite this study. At this time NSF is considering the request and has asked for additional input from NBS. NSF is also evaluating the impact of such an underwriting on the current and future research programs.

Question: What is the impact of the reorganization of the engineering directorate on the emphasis and the number of NSF staff available to oversee the Earthquake Hazard Mitigation Program?

Answer: Prior to reorganization, the Earthquake Hazard Mitigation section was staffed by a Section Head and five Program Directors. After reorganization, the program is staffed by four Program Directors with one Program Director serving as Program Coordinator. We believe that this lower staffing level is sufficient to manage these activities effectively.

19. Societal Response Earthquake Program

Question: What is the rationale for eliminating Societal Response?

Answer: Societal Response has been discontinued only in the sense that it does not have an identifiable or separate budget. However, because societal factors are an integral aspect of earthquake engineering and hazard mitigation, they will continue to receive attention in the program. For example, questions related to technology transfer and the utilization of research results by practitioners and decision makers will be given special attention. We do not believe the overhead associated with a separate program can be justified.

Question: What other agency could support this type of research?

Answer: NSF has cooperated with both the USGS and FEMA on some dissemination projects and research in this area. Also, FEMA has been a major user of NSF sponsored societal response research results. While these agencies do not have separate research programs in this area, their activities do address issues related to technology transfer and utilization of research results by practitioners and decision makers. In fact, FEMA has just established an Earthquakes and Natural Hazards Program Division in response to GAO recommendations.

20. Continental Scientific Drilling Program

Question: H. J. Res. 648, Sec. 323, expresses Congressional support for the Continental Scientific Drilling Program. The resolution calls for "a joint cooperative effort among the U. S. Department of Energy, the National Science Foundation, and the U. S. Geological Survey." What is the specific role of NSF in the interagency Continental Scientific Drilling Program? How is NSF cooperating with DOE and USGS in this program?

Answer: The Interagency Accord on Continental Scientific Drilling, which was signed by the Department of Energy, the U. S. Geological Survey and the National Science Foundation on April 2, 1984, makes a distinction between funds for drilling operations and funds for scientific research. Drilling operations will be funded by the agency with the most interest in the goals addressed by a particular hole. As an example, the NSF will normally fund drilling for information on deep basement structures, while DOE will fund volcanic and geothermal projects, and USGS, earthquake fault studies. All agencies will share in funding the scientific research for each drilling project as appropriate to their missions.

The NSF cooperates closely with DOE and the USGS through an Interagency Coordinating Group established specifically for the management of the Continental Scientific Drilling Program.

21. Alternative Biological Resources (ABR) Program

Question: What is the rationale for eliminating ABR? Are other Federal agencies or the private sector supporting the type of research which will be eliminated? Please give examples.

Answer: There are two major reasons for eliminating ABR. The program's focus on the use of biological systems as alternative sources of chemicals and materials represents applied research that is sometimes more appropriate for mission agencies such as DOE and USDA, e.g., the biological conversion of lignocellulose and the use of arid land plants (such as guayule and jojoba) as sources of industrial chemicals and materials. The ABR Program has been a very small effort at NSF, with much larger investments in closely related areas by the mission agencies. A second aspect of the rationale for eliminating ABR is that the disciplinary programs in biology at NSF can as effectively evaluate the appropriate fundamental research that ABR now handles, and the overhead associated with a separate program is unnecessary.

Question: The NSF Budget (pages BBS-I-8) states, "The more fundamental and most meritorious of the research previously supported by Alternative Biological Resources will be considered in FY 1986 by the most appropriate program elements in the Cellular and Molecular Biosciences Subactivities." Please give examples of the types of fundamental research you would consider funding in this area. Would support of biomass research be continued?

Answer: All fundamental research currently supported by ABR would continue to be appropriate for funding, but as the research questions become more applied, support from NSF would be inappropriate. For example, fundamental studies of biological nitrogen fixation would be supported by the Metabolic Biology Program and basic research on understanding the structure and breakdown of lignocellulose would be appropriate for the Biochemistry Program. The support of fundamental biomass research would also be continued, but with an emphasis on new knowledge, not applications.

ANSWERS TO QUESTIONS CONCERNING SCIENCE AND ENGINEERING EDUCATION

1. Resource Allocation and Expenditure

Question: For fiscal years 1983, 1984, and 1985 (through March 1, 1985) by subactivity: the number of proposals received, the number of proposals having completed the peer-review process, the number of proposals considered by the review process to be worthy of an award, the number of proposals funded, the total expenditure of funds, and the percentage of funds obligated during each quarter of these fiscal years.

Answer:

A. Graduate Fellowships Subactivity

	FY 83	FY 84	FY 85
# New applications received	3,830	4,449	5,002
# New applications completed peer review process	3,830	4,449	5,002
# New applications recommended by peer review process	1,797	2,022	2,338
# New awards made	500	600	-0-
# New applications declined	3,330	3,849	-0-
Total # fellows supported	1,390	1,460	1,500
Total funds awarded as of 3/19/85	$15.0M	$20.3M	$0.0M

B. Precollege Subactivity

	FY 83	FY 84	FY 85[a]
# proposals received	281[b]	1,065[b]	440
# proposals completed peer review process	106[b]	549[b]	659[c]
# proposals recommended by peer review process	106[b]	274[b]	220[c]
# proposals funded/to be announced [a]	106[b]	274[b]	117[c]
# proposals declined and withdrawn	--	275	302[c]
# proposals carried forward	175	516	--
# proposals pending	--	--	534[c]
Total Funds Awarded[a]	$1.1M	$37.2M	$18.5M
Funds Carried Over	$13.9M	$31.5M	--

[a] FY 1985 as of March 19

[b] includes 104 Presidential Awards for Excellence in Science and Mathematics Teaching

[c] includes proposals carried over from FY 1984

C. College Science Instrumentation Subactivity (started in FY 1985)

# proposals received	1,350
# proposals completed peer review process	1,350
# proposals recommended by peer review process	750

(The Foundation plans to announce about 200 awards on May 31.)

Total Science Education Spend Out Rates
By Quarter for FY 1983, FY 1984, and FY 1985

	1983 1st QTR	1983 2nd QTR	1983 3rd QTR	1983 4th QTR	1983 Total	1984 1st QTR	1984 2nd QTR	1984 3rd QTR	1984 4th QTR	1984 Total	1985 1st QTR	1985* 2nd QTR	1985* Total
						(In Millions)							
Amount Obligated CY Appropriation	.012	.042	.736	15.80	16.59	.137	.900	2.493	40.02	43.55	.125	3.997	4.12
Amount Obligated from Prior Year Carryover						.03	4.37	6.5	3.0	13.9	2.3	13.1	15.4
As a Percentage of Total CY Obligations	0	0	4%	96%		0	9%	16%	75%		NA	NA	
As a Percentage of the Appropriation	0	0	2%	53%		0	1%	3%	53%		0%	5%	

(1983 Appropriation = 30 million -13.9 million carried over to 1984)
(1984 Appropriation = 75 million -31.5 million carried over to 1985)
(1985 Appropriation = 82 million -31.5 million carried over to 1986)

* As of 3/15/85

2. Staffing Patterns

Question: For fiscal years 1983, 1984, 1985 (through March 1, 1985), and projections for 1986, the number of full-time equivalent positions allocated, filled, and vacant (as appropriate).

Answer:

	FTE	Positions*	Filled	Vacancy
October 1982	21	23	20	3
October 1983	45	50	26	24
October 1984	53	58	48	10
March 1985	53	58	56	2
October 1985	55	61	--	--

*FTE +10%

3. Proposed Deferral of $31.5 million from FY 1985

Question: If the deferral is not approved by Congress: Are the quantity and quality of proposals received and reviewed by NSF adequate to expend the FY 1985 appropriated level? Are there other barriers to expending the appropriated level in FY 1985? What level of funding would NSF request for FY 1986? How will funding be sustained to avoid a "roller-coaster" funding pattern between FY 1985 and FY 1986?

Answer: The $31.5 million deferral is a planned carryover of precollege funds that we believe cannot be prudently obligated in 1985. We have no reason to change this conclusion, even if a formal deferral is not approved by Congress.

The "barrier" at this point is a clearly defined set of programs which are effectively coupled to the massive investment--almost $150 billion--being made in precollege education by Federal, state and local authorities, as well as private sources. Congress appropriated $2.0 million in 1985 to develop such a plan, and we will initiate an RFP this spring to request these planning studies.

The SEE proposals we have seen so far have been mixed. This is partly due to the fact that the program is new and is just coming into focus. Even a collection of excellent proposals, however, does not necessarily make a cohesive program.

We expect this to change as the objectives become more clearly defined through the planning process, but it will not happen in 1985. If we cannot prudently spend the amount available for precollege activities, we would carry over excess funds into 1986. In doing so, we would avoid the "roller-coaster" funding pattern.

4. Partnerships in Education

Question: How does NSF plan to implement the goals and objectives of the Education for Economic Security Act (P.L. 98-377), especially the partnerships in education concept?

Answer: The Foundation supports the purpose and intent of the Education for Economic Security Act (P.L. 98-377). In particular, the Foundation agrees with the philosophy that is evident in many specific provisions of the Act:

- o The emphasis on partnerships among universities, local and state governments, industry, and the Federal government is important. I have spoken frequently on this need in other contexts. It is embodied in our program guidelines for Science and Engineering Education (SEE) and in other programs such as Presidential Young Investigators and Engineering Research Centers.

- o The stress on improving cooperation between departments of mathematics and science and departments of education is another point of agreement.
- o The emphasis on providing services to segments of the population that are underrepresented in science and engineering is a long-standing priority of the Foundation which is embodied in many programs.

Many of the programs that P.L. 98-377 authorizes are consistent with the President's program for FY 1985 and with the NSF Act. We are implementing such programs in FY 1985 to the extent that appropriations allow.

Since there was no appropriation to accompany P.L. 98-377, however, we are not implementing provisions of the Act that differ from the President's program for 1985. This applies in particular to specific administrative requirements of P.L. 98-377 concerning cost-sharing, joint submission of proposals, distribution requirements, and funding ceilings. This position with respect to appropriations is consistent with explicit guidance we have received from the cognizant Appropriations Subcommittee in the House.

As indicated in the President's statement that accompanied the signing of P.L. 98-377, the Administration believes that the Act provides authorization that is unnecessary and administratively burdensome. The Administration therefore will not request reauthorization of Titles I and III of the Act.

As requested, we shall be providing you, by May 31, 1985, with a long-range strategic plan for accomplishing the elements of all the programs in the Science and Engineering Education Directorate. This plan is being developed by our staff in consultation with the Directorate's Advisory Committee under the chairmanship of Dr. Kenneth Hoffman of the MIT Mathematics Department. Please be advised that we are also issuing a Request for Proposals aimed at providing NSF with a range of options for strengthening and expanding the scope and management of our science and engineering education programs. I want especially to emphasize my desire to work with Congress to achieve a strong program in Science and Engineering Education. Establishing the proper mix of programs and providing for the orderly growth of the SEE activities remains one of the Foundation's highest priorities.

APPENDIX II

American Chemical Society

OFFICE OF THE
PRESIDENT

Ellis K. Fields
President-Elect, 1984
President, 1985
Immediate Past President, 1986

1155 SIXTEENTH STREET, N.W.
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February 28, 1985

The Honorable Doug Walgren
Chairman
Subcommittee on Science, Research and Technology
Committee on Science and Technology
U.S. House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

The American Chemical Society welcomes this opportunity to present its views on the proposed FY 1986 budget for the National Science Foundation. Our comments focus on the NSF Chemistry Division, instrumentation, facilities, the Directorate for Science and Engineering Education, and the Directorate for Scientific, Technological, and International Affairs.

NSF CHEMISTRY DIVISION

The American Chemical Society urges that increased funding for chemical research be given a high priority in the deliberations of the Subcommittee on Science, Research and Technology. In proportion to its contribution to the economy, chemistry has been and is currently underfunded.

Chemistry is entering a new era of productive inquiry as a result of advances in the understanding of the elemental steps of chemical change, and the existence of powerful instrumental techniques. The February 22, 1985 issue of Science magazine is devoted to exciting areas of chemistry which are indicative of this potential. However, chemistry's contribution to the Nation will not be fully realized unless the base funding support for the chemical sciences is increased and this increase is sustained.

Chemistry is a fundamental, central discipline from which many other sciences flow. The chemical sciences have been instrumental in the development of U.S. society, and they likewise will play a significant role in our Nation's future. These sciences are not only the backbone of today's chemical and allied products industries, but they also underlie the high technology industries, such as computers, electronics, robotics, and biotechnology. An estimated forty percent of the U.S. GNP is derived from the chemical sciences if food production and energy technology are taken into account. The chemical industry's shipments abroad yielded a trade surplus that averaged $10.6 billion per year from 1979-1983, making the U.S. chemical and related products industry a strong international competitor. Advances in these industries, and subsequent scientific and technological leadership by the U.S., will depend upon continued support of research in the basic chemical sciences as well as experienced personnel trained in the chemical and allied sciences.

While the Chemistry Division is the major source of funds for basic chemical research at NSF, other Divisions of the Foundation support related activities. The following remarks will be limited to the Chemistry Division, but these comments, in principle, could be extended to all NSF funding for the chemical sciences.

The NSF FY 1986 budget for the Chemistry Division is slated for a 7.0 percent increase. However, in order to address the significance of the proposed budget, the real magnitude of the increase needs to be examined in relation to prior funding patterns and future growth potential. It is important to recognize that although we are in a time of budget austerity, we must not lose opportunities for scientific advancement. These opportunities are available to us in the subfields of chemistry and in interdisciplinary research involving chemistry.

The FY 1986 budget is best understood if placed in a historical context. The funding history of the Chemistry Division in current and constant dollars is presented in Appendix I. Budget appropriations for basic research in chemistry have increased 2.5 times during the period 1973 to 1985. However, in estimated constant 1972 dollars, this increase represents an uneven growth pattern in funding of the Division which averages out to only a four percent annual increase. These figures indicate that basic chemical research has simply maintained a marginal growth when inflation is taken into consideration during this period. Maintenance or even low-level growth is insufficient when considering the contributions that the chemical sciences have made and will make to American society.

In the ACS analysis of the FY 1985 and 1986 budgets for the Chemistry Division, we have subtracted out the amounts earmarked for the two new initiatives--Chemistry of Life Processes and Materials Chemistry. This calculation indicates that the costs of the new program initiatives have been partly absorbed by the established subactivities of the Chemistry Division [Appendix II]. The Division will continue to deny high quality proposals in these established areas because of insufficient funds. Since the number of investigators receiving scientific research project support will remain at approximately 875, these new initiatives will make funding decisions more difficult starting in FY 1985.

Broad support for basic research across subfields is vital to the advancement of chemistry since it is impossible to predict where discoveries will occur. The consequence of not pursuing all good research translates into lost opportunities that in the long-term will be detrimental to the health of science and to the economy as well. Moreover, support by NSF of basic research is important to the health of chemistry as a discipline, particularly at academic institutions since the Chemistry Division in FY 1984 provided forty-one percent of the federal support for basic chemical research performed at universities and colleges.

The ACS favors setting research priorities and understands the need to cut back programs in order to reduce the federal budget deficit. However, the Society believes that the proposed funding level for the NSF is by no means the optimum. The opportunities before us in the chemical sciences would justify--even in a time of fiscal restraint--a far larger amount than is proposed.

Other scientific organizations have recognized the importance to the Nation of supporting promising chemical research areas. The National Academy of Sciences panel, which briefed the Office of Science and Technology Policy on chemistry in 1983, noted three such research areas in which a substantial infusion of federal funding would allow the exploration of new territory on the cutting edge of chemical science. These frontiers are: (1) chemical reactivity, (2) chemical catalysis, and (3) chemistry of life processes.

Only one of these areas, chemistry of life processes, has been targeted for specific NSF funding. The chemistry of life processes involves the application of basic chemistry techniques and principles to the solution of molecular life processes. Failure to fund sufficient research on the chemical aspects of biology could cost the U.S. its leadership in biotechnology and applied biology.

The NAS panel suggested that the chemistry of life processes be funded at a level of $25 million per year, with $10 million of this yearly amount available as grants. NSF funding for the Chemistry of Life Processes initiative is significantly below these recommended amounts. This means that many excellent research proposals in this emerging area will be inadequately funded or will not be supported at all.

In the Society's view, NSF plays a key role in ensuring the exploration of opportunities in basic chemical research in areas that are not pursued by the mission agencies. The Society believes that NSF cannot adequately perform this function within the constraints of the proposed FY 86 budget. Consequently, ACS urges that funding for chemical research be given a high priority in the Foundation's FY 1986 budget.

INSTRUMENTATION

Achieving progress in the research areas receiving Foundation support depends on access to modern instrumentation. The survey conducted in 1982 by the ACS Committee on Science--"Instrumentation Needs of Academic Departments of Chemistry"--found that the average age of the instrumentation in U.S. chemistry departments was between eight and nine years [Appendix III]. In the experience of laboratory managers, retaining most instrumentation beyond seven or eight years is unwise. Given new developments in the field, instruments continuously become scientifically and technologically obsolete. The ACS survey results also indicated that fifteen percent of the equipment at smaller chemistry departments, and nine percent at major ones, was not fully operational in 1982. Therefore, given the age of the equipment, maintenance becomes an increasing problem.

The ability of chemists in academe to conduct research at the cutting edge of science is limited by the age and condition of their equipment. The ACS estimated that the one hundred major U.S. chemistry departments would need $83.2 million for instrument purchases; the 470 smaller chemistry departments would need $65.5 million. The Society projected that with the addition of maintenance, technical support, and other ancillary costs, $500 million may be required to update and maintain equipment in a manner necessary to ensure progress in chemical research. The need, as estimated by the ACS study, is so great that both private sources and government programs must be utilized to address this problem.

The ACS is aware of the National Science Foundation's efforts to survey the need for and to fund instrumentation purchases. The Society especially commends the Foundation for assisting both research and undergraduate institutions in this area.

The ACS Office of Science Policy Analysis recently conducted a survey of all the current federal programs funding instrumentation purchases. As a result of the survey, the Society noted that federal program managers were not always aware of the working details of federal instrumentation programs other than their own. The implications of this situation are that, without an exchange of experiences and information, designing the best possible instrumentation program is a difficult, if not impossible task. The magnitude of the instrumentation problem for chemistry and other disciplines is so great that a more coordinated effort is necessary. The American Chemical Society strongly urges the Foundation to strengthen the interactions of the Interagency Working Group on Research Instrumentation so that governmental efforts in this crucial area could be made more efficient and cost-effective.

The American Chemical Society also supports the NSF's continuing commitment to increase access to supercomputers for academic research scientists and engineers. In 1984 the ACS Task Force on Large-Scale Computing completed a review of the kinds of critical chemical research problems that can be studied within a reasonable amount of time only with the use of a supercomputer. The Task Force concluded that supercomputers are an important component in sustaining the health of chemistry.

FACILITIES

In the past, campus "bricks and mortar" has been the responsibility of the public and private sectors. Academic institutions have obtained funding from a variety of sources--alumni funds, corporate grants, foundation grants, and federal government awards. The American Chemical Society believes this should be the continued method of obtaining facilities funding. No one should expect the federal government to solve single-handedly the facilities problem.

The exact magnitude of the facilities problem is not known, but there is a large and growing recognition of the need for funds to build and restore scientific research and education facilities. The ACS recommends that the NSF assess the country's current and projected need for new or renovated scientific facilities. Once such a nationwide assessment has been done, it can serve as a guideline for the consideration of future requests. The National Science Foundation already administers the data collection for instrumentation needs at universities. A similar data base should be assembled and maintained to assess future needs for university scientific facilities.

Although it is difficult to determine the scope of the facilities problem, it needs to be addressed now. One less costly method of dealing with the immediate problems in this area would be to initiate a renovation program rather than fund new starts for R&D and education facilities. Renovation funds should be used for modernizing the necessary safety features, such as fume hoods, needed in both research and teaching laboratories. The American Chemical Society urges that a renovation program be considered for funding in the FY 1987 NSF budget to address the problem of deterioration and obsolescence of existing facilities. Further, the Society endorses some form of merit-based review for such a federal renovation program.

In this time of attempting to control and reduce federal budget deficits, the university community needs to acknowledge and endorse merit-based review as a proven mechanism for and an essential component of choosing high quality projects. In the mid-1970's to early 1980's, the merit-based review process received close scrutiny and only minor changes. Currently, this process is still the most equitable way of guaranteeing careful scrutiny of and excellence in federally-funded basic research projects while assuring the best use of scarce federal funds. Consequently, ACS recommends that some form of merit-based review be established to select the highest quality facility projects.

SCIENCE AND ENGINEERING EDUCATION

The American Chemical Society supports the overall goals of the NSF Directorate for Science and Engineering Education and stands ready to offer its assistance. Specifically, the ACS commends the Directorate for emphasizing the science and mathematics taught in the middle and elementary schools of the U.S. The ACS recognizes good teaching at these levels to be of crucial importance to the development of a scientifically-informed citizenry, and the Society has established a Pre-High School Science Office to work with other concerned groups and associations on the many problems in this area.

The need to support precollege education in science and mathematics has been clearly recognized in a series of reports produced by a number of prominent national commissions. The ACS's own "Tomorrow" report published in April 1984 explicitly enumerates the Society's concern for adequate support of both teacher preservice and inservice training and for the development of new materials for grades K through 12 science education [Appendix IV]. Regrettably, it is in these two areas that the Directorate is, in effect, "losing" funds through the budget deferral process. The ACS is sympathetic to the management concerns of the Directorate, but deplores the need to defer funds from year-to-year. The Society is confident that the Directorate will continue its status as the lead agency in the area of science, mathematics, and engineering education. In order for the Directorate to accomplish this, ACS recommends that: the FY 1985 current plan of $82.0 million be set as the base for the Directorate's FY 1986 budget and that the $31.5 million in deferred funds be returned to the Directorate budget. This additional support should be allocated to the Materials Development and Research subactivity and the Teacher Enhancement and Informal Science Education subactivities, increasing their allotments to $38.4 and $40.8 million, respectively. Our recommendation is that the overall FY 1986 budget for the Directorate of Science and Engineering Education be set at $113.5 million. In making this recommendation, the ACS intends that new money be added to the $31.5 million deferral in order not to reduce support for research in the disciplines funded by NSF.

The American Chemical Society recognizes, as does the Directorate, the importance of working in partnership with others and of establishing communication networks in support of excellence in science and engineering education for all levels of students. The ACS stands ready to give its support to the Directorate in expanding and maintaining such networks.

Finally, the ACS is pleased with the continued support of Presidential Young Investigator Awards. The NSF should be applauded for its continued support of Graduate Research Fellowships through its Research Career Development subactivity. However, the American Chemical Society does recommend that some portion of these funds be awarded directly to institutions of higher learning as competitive block grants for support of their own graduate fellowship programs. The effect of currently awarding all funds to individual students is to channel recipients of these portable fellowships into a few prestigious institutions, resulting in an inequitable distribution of funds and a weakening of promising research programs at other universities. Science only thrives through the creative interplay of diverse ideas as expressed through research conducted at a variety of institutions.

SCIENTIFIC, TECHNOLOGICAL, AND INTERNATIONAL AFFAIRS

At a time when international scientific cooperation is an avenue to world peace and economic development, cuts in the International Cooperative Scientific Activities program in the Directorate for Scientific, Technological, and International Affairs (STIA) are viewed by the ACS as counterproductive. The American Chemical Society believes it is very much in the government's interest to provide support for activities such as attendance at international scientific and engineering conferences, formation of cooperative research and development projects, provision for scientific journals, and reciprocal lecture tours. Support for these activities is the responsiblity of a number of federal departments and agencies, but NSF should have primary responsibility, especially in areas involving basic research.

The ACS applauds the Foundation's continued priority under STIA for research support for undergraduate institutions, women, and minority scientists. The American Chemical Society is pleased that funding has doubled for Research Opportunities for Women and that the program is concerned with career reentry.

The National Charter of the American Chemical Society imposes an obligation upon the Society to provide advice to the government in matters of national concern related to its areas of competence. One of the objectives set forth in the ACS Federal Charter is the promotion of research and the advancement of education. With this objective in mind, we hope that our comments will be useful to the Subcommittee in its deliberations on the FY 1986 budget of the National Science Foundation.

Sincerely yours,

Ellis K. Fields

Ellis K. Fields

Appendices (4)

APPENDIX I

NSF
Chemistry Division Appropriations History 1973-1986
(000 Omitted from Dollar Amounts)

Fiscal Year	Actual/Proposed	GNP Deflator	Constant (1972) Dollars
1973	$25,081	1.044	$24,024
1974	26,645	1.125	23,684
1975	32,728	1.246	26,266
1976	34,650	1.332	26,014
1977	40,226	1.424	28,249
1978	43,050	1.520	28,322
1979	45,230	1.651	27,396
1980	51,451	1.776	28,970
1981	57,622	1.953	29,504
1982	61,356	2.093	29,315
1983	67,628	2.176	31,079
1984	79,427	2.259	35,160
1985	87,400 (proposed)	2.341*	37,334
1986	93,500 (proposed)	2.443*	38,273

*The GNP deflators for 1985 and 1986 are estimates

SOURCE: National Science Foundation

Prepared by: American Chemical Society

APPENDIX II

NATIONAL SCIENCE FOUNDATION
CHEMISTRY DIVISION

(000 Omitted From Dollar Amounts)

Program Title	FY 1984 Actual	FY 1985 Current Plan	FY 1986 Proposed	% Increase 1985-1986
Chemistry of Life Processes[a]	0	$ 2,000	$ 3,500	75.0%
Materials Chemistry[b]	0	6,800	7,700	13.2%
Remaining Chemistry Division	$79,427	$78,600	$82,300	4.7%
TOTAL, Chemistry Division	$79,427	$87,400	$93,500	7.0%

a. - Funding from the Biological, Behavioral, and Social Sciences Directorate for the Chemistry of Life Processes:
FY 1985, $1.5 million;
FY 1986, $1.0 million (estimate).

b. - Figures for funding from the Materials Division are not available at this time.

SOURCE: National Science Foundation

APPENDIX III

INSTRUMENTATION NEEDS OF ACADEMIC DEPARTMENTS OF CHEMISTRY

A SURVEY STUDY

Report
of a joint
Task Force
of the
Committee on Science
and
Committee on Chemistry and Public Affairs

AMERICAN CHEMICAL SOCIETY

April 1984

EXECUTIVE SUMMARY

There is almost a total lack of information on the state of instrumentation at U.S. college and university chemistry and chemical engineering departments. In an effort to correct this situation, the ACS Committee on Science conducted this survey to obtain information on this important subject.

A questionnaire was mailed to 50 major chemistry departments, 112 smaller chemistry departments, and 25 chemical engineering departments. The survey consisted of a series of questions on two broad subjects--the current inventory at the surveyed institutions, and the needs for instrumentation. Responses were received from 32 major and 71 smaller chemistry departments, and 13 chemical engineering departments.

Since only 13 chemical engineering departments responded, 10% of the total number of departments accredited by the American Institute of Chemical Engineers, reliable statistical analysis of the data on chemical engineering departments was not possible and does not form part of this report.

The data indicated that the median value of on-hand instrumentation at major institutions was $3.3 million, while at smaller institutions the median was $104,000. The average age of the instrumentation was between eight and nine years, with the instrumentation at smaller institutions being the older on average.

The seven instruments most commonly mentioned as being either on-hand or most needed were the UV-visible spectrophotometer; gas chromatograph; nuclear magnetic resonance spectrometer; infrared spectrophotometer; mass spectrometer; liquid chromatograph; and atomic absorption spectrometer. These instruments constituted 54.6% of the major institutions' current inventory, and 72.2% of the smaller institutions' inventory.

Instrumentation is usually designated for either research training or undergraduate instruction and sometimes for these two combined. Larger institutions devote three times as much instrumentation for research training as for undergraduate instruction. Predominantly undergraduate institutions devote almost four times the instrumentation for undergraduate instruction as do the major institutions.

Regarding instrument condition, 15% of the instrumentation was not fully operational at smaller chemistry departments and 9% at major ones. Given that the instrumentation is between eight and nine years old, maintenance is a severe problem, particularly at smaller schools where trained technicians are all but nonexistent.

As instrumentation ages, obsolescence becomes more prevalant as well. The increased use of microprocessors, the development of totally new technologies, and the evolutionary improvement of old ones over the past decade have all combined to render instrumentation at the institutions surveyed generally obsolete.

In addition to a profile of the current inventory, an assessment of the respondents' needs for new instrumentation was made. Highlights include:

- a finding that the seven most common instruments make up 73% of the needs at smaller chemistry departments
- NMR instrumentation is needed most by the chemistry departments
- Major institutions plan to use needed instrumentation in roughly the same mix as currently held instrumentation, whereas smaller institutions want to use needed instrumentation for both research and instruction.

Regarding the cost of meeting instrumentation needs, the task force estimates that the 100 major U.S. chemistry departments would need $83.2 million for instrument purchases; the 470 smaller chemistry departments would need $65.5 million. When maintenance and other ancillary costs are included, a total of $500 million may be required.

Among the study recommendations:

- funding agencies should enlarge support for instrumentation purchases, for both research and instruction
- additional ways to finance instrumentation purchases should be explored
- grants for purchase of instrumentation should allow for maintenance costs

NOTE

The full Survey Study on "Instrumentation Needs of Academic Departments of Chemistry", as well the ACS report "Tomorrow" (listed as Appendix IV) are available in the Subcommittee files.

American
Psychological
Association

TESTIMONY OF

Michael S. Pallak, Ph.D.

Executive Officer

AMERICAN PSYCHOLOGICAL ASSOCIATION

before the

UNITED STATES HOUSE OF REPRESENTATIVES

Subcommittee on Science, Research and Technology

Committee on Science and Technology

on the subject of

NATIONAL SCIENCE FOUNDATION AUTHORIZATION

Fiscal Year 1986

March 15, 1985

The Honorable Doug Walgren, Chair

1200 Seventeenth St., N.W.
Washington, D.C. 20036
(202) 955-7600

Thank you for this opportunity for the American Psychological Association to submit testimony on the subject of the National Science Foundation Authorizations for Fiscal Year 1986. The American Psychological Association (APA) represents the concerns of over 76,000 psychologists, many of whom conduct important research that is funded by the National Science Foundation.

Before commenting on the NSF budget request for FY 86, we feel it would be useful to describe the kinds of research in which psychologists engage as behavioral and social science researchers. Their activities form an impressive array of inquiry that ranges from purely physiological phenomena to purely social phenomena and includes such diverse topics as normal and abnormal brain growth and development; educational processes such as learning and memory; the study and design of organizational structures and functions; the study of social institutions and interactions; personnel selection and placement; cockpit design and instrument panel layout based on research in visual perception; survey research; and developing standardized tests for use in education and the business sector. Psychologists' research has implications for problems of health care, productivity, education, substance abuse, and human factors in technology, to name a few. In the last five years, contributions in these areas have been recognized through two Nobel prizes and many other national and international awards to distinguished psychologists.

We would now like to address our comments to the proposed budget for the National Science Foundation for Fiscal Year 1986. APA is generally pleased with the Administration's NSF budget request, particularly with the proposed levels of support for the behavioral and social sciences.

As this Committee knows, the behavioral and social science programs at NSF in years past have been proposed for less than equitable treatment. Fortunately, this trend was reversed in the FY 85 budget, due in large part to the strong support demonstrated by the Science and Technology Committee in its commitment to quality research in these important areas of science.

APA is pleased with the 4.4% increase for the total NSF budget, and in particular we are supportive of the 8% increase for the Biological, Behavioral and Social Sciences (BBS) Directorate. Within the BBS Directorate, the Behavioral and Neural Sciences (BNS) Division provides the bulk of NSF funding for research conducted by psychologists. We are pleased that the BNS Division received a 6.6% increase over FY 85 funding levels.

The BNS Division supports research by psychologists in areas including: Sensory Physiology and Perception, Psychobiology, Memory and Cognitive Processes, and Social and Developmental Psychology. We feel that the increases proposed by the Administration in each of these areas are a strong indication of the Administration's continued commitment to basic research, as well as an increased awareness of the significant contributions of behavioral and social science research. These increases become even more significant in view of the fiscal constraints placed on the budget this year by the size of the federal deficit.

We are also pleased that within the Behavioral and Neural Sciences programs, NSF is encouraging emphasis on teaching and learning research in the

Cognitive Science program. APA strongly advocated increased support for important research on teaching and learning in the FY 85 budget, and we were gratified when Congress approved a $5 million addition to last year's budget directed specifically to teaching and learning research.

We also support the research on teaching and learning that will be funded within the Science and Engineering Education (SEE) Directorate. Psychologists share concerns expressed by this Committee in the past that improvement is needed in our nation's science education activities. Psychologists and others involved in education-related research have made significant strides toward establishing a knowledge base on the processes of learning, cognition, and teaching and, specifically, in understanding the ways in which science and mathematics are most effectively taught. For example, cognitive researchers have analyzed the ways in which experts approach a problem to discover possible shortcuts to acquiring the skills possessed by high-quality scientists. Improvements in science education are necessary for the U.S. to remain competitive with other countries in our own industries and other areas where innovation is needed.

We would also like to express our support for the 6.7% increase in the Information Science Division of BBS. The Information Science Division supports important research in such areas as improving the understanding about the way information is structured, represented and used; improving the interaction of human users and information processing systems; and on understanding the effects of information and information technologies on economic and social processes. This Division is important to behavioral and social scientists, as approximately 40% of its budget funds research in these fields.

APA is very concerned, however, about the proposd elimination of the Ethics and Values in Science and Technology (EVIST) program in the Science, Technology and International Affairs Directorate at NSF. This important program has served a valuable role in funding research on the ethical and moral impact of the nation's scientific and technical advances. We feel strongly that funding for this program should be retained.

The concerns we raise above should not outweigh the positive regard with which we view the President's FY 86 NSF budget. We are pleased that the budget proposal recognizes that it is critical to the future of our country that we maintain a continuing commitment to the behavioral and social sciences. These are the sciences that study human behavior and thought, and there is hardly a single national problem the solutions to which do not demand some understanding of human nature. Let me provide some examples:

- Today, we routinely employ survey research methodology in studies of the American economy; studies that business uses to make critical investment decisions, that the government uses to predict future revenues and reaction to potential alternative policy strategies, and that innovators use to assess the market potential for new products. This methodology rests on accumulative scientific efforts going back to the 1920's relating to attitude measurement and statistical sampling techniques.

- Human factors research in the behavioral sciences is routinely employed in American business and around the world. Examples are numerous, ranging from the layout of control rooms in nuclear reactors, to the design of flight panels in airplanes, in which the cockpit design has been based on fundamental studies of eye-hand coordination, as well as a large number of studies in basic production units on the shop floor. Such studies contribute to human safety, to productivity, and to innovation.

- Behavioral and social sciences have contributed directly to the management of the research and development process in other sciences. Existing literature has been directly related to the composition of research teams, the organizational structure of research organizations, and the relationship of R&D to other functions of a business firm, such as marketing. In some of the more innovative and productive American firms this knowledge is used routinely to guide research processes, often with direct increases in research productivity.

- The management structure and processes of American industry are often based on straight-forward behavioral science research. This research includes studies of the relationship of morale and employee satisfaction to productivity, the effects of employee participation in decision-making on productivity, the nature of resistance to change of management practices, employee profit-sharing plans, and the relationship of styles of leadership to group productivity.

- The potential of the behavioral sciences to contribute to the country's adjustment to rapidly changing technologies is also an area of great potential. As one example of the interplay between technology and human behavior, consider the problem of energy use. The development of energy sources and the refinement of techniques of production of energy are clearly problems for the engineering and physical sciences. However, the patterns of use of energy are almost entirely a question of human attitudes and behavior. Here conservation rests on such simple behaviors as turning a switch on or off, monitoring one's own behavior in such actions as turning up the thermostat in the summer and down in the winter, and the acceptance and/or purchase of alternative modes of supply.

- A recent report by the Surgeon General titled, "Healthy People" examines the 10 leading causes of death in the United States and concludes that seven of these are in large part behaviorally determined and could be substantilly reduced by changing behaviors. This means changing the habits of individuals, including those related to diet, exercise, dental habits, smoking and drinking. The beginnings of important research on these topics can be traced back 35 years in the behavioral sciences to research on the change of dietary habits during the Second World War.

Basic behavioral and social science research will continue to play a vital role in addressing many of the long-range issues that face this country. We strongly urge Congress to approve NSF's FY 86 budget request for the behavioral and social sciences.

Thank you again for the opportunity to submit testimony on the Administration's FY 86 budget request for the National Science Foundation.

THE NATIONAL SCIENCE FOUNDATION
Fiscal Year 1986 Budget

Subcommittee on Science, Research and Technology
House Committee on Science and Technology

February 20, 1985

The American Society for Engineering Education
W. Edward Lear
Executive Director

THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Fiscal Year 1986
National Science Foundation

February 20, 1985

Mr. Chairman and members of the Subcommittee:

The American Society for Engineering Education welcomes this opportunity to comment on the proposed Fiscal Year 1986 budget of the National Science Foundation. The engineering activities of the NSF are undergoing profound changes and we appreciate the chance to speak in support of the direction in which those changes are leading.

ASEE's membership is drawn from over one hundred major employers of engineers, several government agencies, the national engineering societies, the more than 250 accredited engineering schools of the nation, and over 10,000 individuals, many of whom are faculty and students. Each of our members has a deeply rooted concern for the health of the national engineering education enterprise.

In addition, ASEE has the pleasure of working with the National Society of Professional Engineers (NSPE) and the National Association of State Universities and Land Grant Colleges (NASULGC) as part of the national Engineering Education Task Force. Last year the Task Force testified before your Subcommittee in support of an engineering mission for the charter of the National Science Foundation.

We are gratified to learn that the engineering mission language is part of the agency's budget request for Fiscal Year 1986.

ASEE is pleased to be part of a growing movement to promote understanding of the rich contribution that engineering makes to our lives. The fruits of engineering improve our standard of living, strengthen our economy, enhance U.S. competitiveness abroad, and provide for a strong national security. As the world moves swiftly and surely into reliance on the gifts of high technology, engineering will play an ever more pervasive role in daily living. Personal computers used by millions, life-enhancing medical technology, new and stronger materials, and vital communications systems are only a very small sampling of the countless ways in which engineering already touches our lives and will continue to do so in the future.

We cannot assume, however, that these blessings will come to us without effort. Well-trained people with imaginative ideas and the tools to realize those ideas will be needed by the end of this century in ever increasing numbers. Such innovators do not materialize without hard work or without the support of those who will materially benefit from their endeavors. To make the American dreams of tomorrow come true demands a commitment today to strengthening every link in the innovative chain which produces U.S. technology.

Recognition of the complementary partnership of science and engineering is an integral part of the process of strengthening this chain. Too often engineering is miscast as a subset of science rather than understood to be a distinct field with over a score of fully-developed disciplines, each of which generates new knowledge. This inaccurate characterization masks the inherent synergism between the two fields. Enlightenment in one often opens the door to discoveries in the other. Together they advance the pool of knowledge available to solve human problems. If we are to make the very best use of our resources to advance U.S. technology we must promote this partnership to the fullest extent possible.

Only recently has attention been focused on the problems facing the engineering "link" of the innovation chain. Mounting pressure on the country's engineering schools to meet industry's and government's needs for well-trained, highly-talented engineers threatens to undermine our overburdened education system and, by extension, the strength of U.S. engineering. If the nation's engineering component is weakened, the entire innovation process is weakened.

The problems faced by engineering schools are as complex and diverse as the schools, students, faculty, industry and government which compose the enterprise. Several concerns, however, seem to cut across individual difficulties to have captured the attention of those who have a stake in the state of engineering education.

A continuing shortage of qualified engineering faculty poses a grave threat to the ability of schools to maintain both the quality and quantity of needed engineering graduates. Latest figures from 1983 estimate a faculty vacancy rate of 8.5% -- which translates to a high 23% when one accounts for the quantity of faculty required to restore the student-faculty ratio of the 1960's. Initial assessments of the factors exacerbating the shortage cite obsolete university facilities and equipment in laboratories, the lure of higher pay and more advanced equipment in industry, burgeoning undergraduate enrollments, the high cost of graduate education, and burdensome faculty administrative duties as disincentives for young, bright graduates to pursue academic careers. Unless these conditions are reversed, engineering schools stand to lose out on bidding for the finest engineering minds to teach and to conduct the fundamental engineering research which sustains the schools and U.S. technology.

Following are several facts which highlight some of the problems faced by engineering schools:

- While student undergraduate enrollment in the past decade in engineering has doubled, the number of engineering faculty has increased by only 10 percent;
- The disparity between student and faculty growth has resulted in a 32% increase in the student-faculty ratio over the last decade;
- The number of engineering doctoral degrees awarded to U.S. citizens by U.S. universities declined dramatically over the last decade, while the number of such awards to foreign nationals by U.S. schools has risen, now accounting for about 40% of all engineering Ph.D.'s;
- In 1983, of the total 18,540 full-time Ph.D. candidates in engineering, 7,687 were foreign nationals;
- Demographics project a 17% decrease in 22-year olds by 1990. This decrease will further limit the pool of engineering students who will continue on to the Ph.D. and ultimately choose academic careers;

- Studies of equipment shortages in engineering schools carry estimates up to $2 billion to bring university labs up to industry standards;

- An Association of American Universities report to the National Science Foundation in 1980 concluded that equipment used in top-ranked universities has a median age twice that of instrumentation available in leading industrial research laboratories;

- A recent study by the National Science Foundation found that 43 major research universities classified their equipment as 25% obsolete and only 16% state-of-the-art.

Clearly our engineering schools are in trouble. If no action is taken to relieve these problems, the field of engineering and the future of the nation's technological achievements will be sorely diminished.

Industry is beginning to recognize the need to help engineering schools. It sees that the problems faced by the schools will lead inevitably to poorly-prepared gradutes unable to contribute to industry's needs. Cooperative arrangements which are mutually beneficial to companies and to universities can be expected to flourish in the future as both communities recognize fully the importance of a unified effort.

For the federal government, too, there is an important and an appropriate role in strengthening the nation's engineering education system. The NSF plays a vital part in supporting through fellowships the graduate students who will become tomorrow's young faculty. Research grants also sustain faculty and contribute to equipment and facilities needs. These are extremely important to the health of our schools and should be continued and strengthened where possible.

One major area of weakness, however, has not been fully addressed by either industry or government -- the support of fundamental engineering research. Support of such research is weak and inconsistent, to a large extent due to misperceptions about the nature of the research. Because it is substantially generic in nature -- without specific application or a goal of product development -- industries seldom can commit themselves to the long-term support of fundamental engineering research. However, the discoveries revealed through the research underpin the entire engineering enterprise by introducing new processes and systems which may spark specific innovations.

Government, too, has been hesitant in its support of fundamental engineering research, perceiving it to be commerialization-oriented, and thus appropriately the responsibility of the private sector. Increased understanding of the generic and long-term goals of fundamental engineering research, however, is beginning to filter through the government support network.

These misperceptions by both industry and government have been unfortunately detrimental to developing to its fullest potential the engineering "knowledge base" upon which technology rests. Underinvestment in this important research also affects a particularly important component of the engineering education enterprise -- students. Through research support in the schools students learn to work with the equipment, processes, and innovative ideas which they will later try to develop into products in industry.

The academic engineering community has been heartened by the recent activity at the National Science Foundation. Increased recognition of the role of engineering at the NSF bodes well for enhancing the valuable partnership between science and engineering.

Specifically, we are delighted to see that the budget request for the National Science Foundation for Fiscal Year 1986 includes language which will enhance the Foundation's ability to support engineering. This is a very important step in providing the stable and secure home for engineering on the federal level which will promote the best use of our national engineering resources.

Secondly, the reorganization of the Engineering Directorate has great potential for allowing NSF to be responsive to the emerging and traditional needs of fundamental engineering research. Although time will be required to maximize the new arrangements, the changes should ultimately enhance our ability to compete globally in critical technologies, to meet our high goals of quality and productivity, and to provide an environment which may foster much innovation.

Thirdly, the strengthening of the Engineering Directorate's budget continues to be extremely important. After years of benign neglect, the newly developoing engineering component of the NSF needs to grow. While recognizing the imperative to reduce our federal deficit, and also wishing in no way to advance engineering at the expense of science, we nonetheless strongly believe that the growth curve of the Engineering Directorate must continue its positive trend if we are to achieve our most fundamental goals. Engineering still garners only approximately 10% of the Foundation's budget despite recent improvements in funding for the Engineering Directorate.

Important initiatives such as the Engineering Research Centers must flourish, but in tandem with growth in engineering activities overall. The reactivation of the Science and Engineering Education Directorate, with its vital fellowship programs, and the continued support for the Presidential Young Investigators Awards also deserve our full attention. These signs of growth are signs of investment in our future.

The National Science Foundation is a fundamental partner in the future of U.S. engineering, as engineering is a fundamental partner in the future of U.S. technology. Through thoughtful use of NSF's considerable experience in promoting the finest in the sciences, we can develop a strong system of support for our engineering efforts. The National Science Foundation's growing contribution to the strength of our country's engineering enterprise deserves our unwavering support. We hope that you will agree.

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W. Edward Lear
Executive Director

Comments on

The National Science Foundation
FY 1986
Budget Request

Submitted to:
Subcommittee on Science, Research and Technology
Committee on Science and Technology
U.S. House of Representatives
February 21, 1985

Prepared by a Task Force of
The Council on Education
The American Society of
Mechanical Engineers

Mr. Chairman and Members of the Committee:

We appreciate the opportunity to submit our views on the proposed fiscal year 1986 budget of the National Science Foundation. The American Society of Mechanical Engineers (ASME) is an educational, scientific and charitable society founded over 100 years ago. Membership in ASME exceeds 110,000 mechanical engineers. This statement was prepared by a Task Force of the Council on Education of the American Society of Mechanical Engineers. It represents the considered judgement of the Task Force, a group of experts in the field, rather than an official position of ASME.

ASME has a vital interest in the successful implementation of the full range of NSF programs, however these comments focus primarily on those aspects of the budget request affecting the contributions of engineering research to the national goals.

The Task Force endorses the testimony of NSF Director Erich Bloch before this Committee on February 6 regarding the need for a sustained high level of Federal support for basic science and engineering research. This support is required to insure continued U.S. pre-eminence in the world-wide marketplace and for economic and national security. We are especially pleased with the Foundation's long-term commitment to ensure stability of basic research programs. We are also pleased with the initiatives to restore support for science and engineering education which has been drastically curtailed in the 1982-83 period.

The 1986 National Science Foundation budget, totaling $1,596.4 million, represents an increase of $66.7 million over the 1985 level--a 4.4% increase. Of this total, $1,397.8 million is earmarked for research and relateo activities. Mr. Bloch has stated that, "The areas marked for increases were selected either because they would contribute to economic competitiveness, because they strengthen the Nation's science and engineering infrastructure, or because NSF has special responsibility for such areas."

The Task Force supports the thrust of the NSF budget request for increased support of research and education in engineering. The proposed $20 million increase for engineering amounts to a 13.3 percent increase. However, the dollar amount is much less than the increase for science. Thus, while much of the change in structure is occuring in engineering, the resulting budgetary increase is not extraordinary. The Foundation is still predominantly science oriented; we hope that engineering will receive even greater support in future years.

Among the more interesting facets of this budget is the major restructuring within the engineering directorate. The new structure includes six program areas, including two programs titled, "Emerging and Critical Engineering Systems," and "Cross-Disciplinary Research". The former of these is directed at more high-risk research support with possible major breakthroughs in new technologies, such as biotechnology, bioengineering, and light wave technology. "Critical Engineering Systems" are described as those essential to the Nation's safety, well being, and international competitiveness. Such a thrust is a departure from the more traditional research mission of NSF pursuing knowledge for its own sake. This mission is maintained in the science disciplines, but in engineering, a more problem-oriented approach has emerged.

The Cross-Discipline Research program is the home of the Engineering Research Centers. This program has grown from its initial budget level of $10 million in FY 1985 to $25 million is its second year of existence. It is contemplated that each center will be funded by NSF at a level from $2.5 to $5.0 million per year for five years. The focusing of cross-disciplinary research at a select number of university centers represents a new funding concept for NSF. The focus of these Centers will be to develop the knowledge needed to prepare engineers is areas critical to the competitiveness of U.S. industry and to alleviate shortages of personnel in these areas.

The programs of NSF to upgrade and modernize equipment and instrumentation in university research laboratories are also critically important. These needs have long been recognized, however, the rapid change in the technology of research instrumentation has oftentimes exceeded resources available to researchers to conduct experimental work at the "cutting edge" of basic research. The Foundation's special emphasis on replacement of worn-out and outdated equipment and facilities will greatly improve the research capabilities of our nation. We have noted that $21.7 million dollars has been identified in the NSF Budget for support of engineering R&D facilities, equipment and instrumentation in the coming year, an increase of nearly 23% over the current year.

The Engineering Directorate has also altered its divisional structure in the more traditional areas. The three engineering science subactivities carry the titles: Chemical, Biochemical, and Thermal Engineering; Mechanics, Structures, and Materials Engineering; and Electrical, Communications, and Systems Engineering. The latter of these has clear ties to the electrical engineering community. The other major engineering disciplines--civil, mechanical, and chemical--are distributed among the other programs.

The remaining subactivity is designated Design, Manufacturing, and Computer Engineering. This new collection of traditional areas is thought to be lacking a broad base of scientific knowledge, and it is the aim of this subactivity to achieve this base through research.

An often stated concern of those reviewing this new structure is the fate of the type of researcher who has been funded over the years by NSF to do basic research on a relatively small scale. It is common, at present, for NSF-funded programs to operate at less than $100,000 per year. The present university research community has evolved to operate on this scale in accord with NSF funding philosophies. Mr. Bloch and the Assistant Director for Engineering, Dr. Nam Suh, have repeatedly stated that these types of research activities will be maintained and that new ventures will be supported by new funding. At present, this appears to be the case for the FY 1986 budget, but there is sincere interest in engineering education about continuing the relatively modest single investigator-initiated research. Our comments on the Engineering Subactivities follow:

Engineering Science in Chemical, Biochemical, and Thermal Engineering:

A science-based subactivity, the CBTE thrust is oriented toward phenomena which are related to chemical, biological, and thermal processes. These areas have been among the most active university research programs and where NSF has received a very large number of investigator-initiated proposals.

With level funding, NSF is not expanding efforts in these program areas. The area of energy research--a very active and important topic a decade ago--is apparently thought not to be one of those currently "critical". We believe basic research in energy-related topics is of great importance and if NSF is not stressing it, more attention is needed at the Department of Energy.

Chemical engineering research has not experienced great change in this new organization. While two relatively small programs have been moved elsewhere, it appears that heat transfer and thermal systems research will now be directed totally within this subactivity. Mechanical engineering departments, on the other hand, doing research in traditional areas of heat transfer, solid and fluid mechanics and design and manufacturing, must now seek funding from three different subactivities.

Engineering Science in Mechanics, Structures and Materials Processing:

Mechanical engineering research support within NSF has been less than electrical, chemical and civil engineering levels, and this issue deserves attention in view of new productivity demands, needs for increased graduate programs and demands for graduates.

The purpose of this new subdivision is to expand the engineering science base in solid and fluid mechanics, structures and materials. The goal of the research supported in this division is the application of the results to all engineering fields incorporating these disciplines. There are six programs in this division: solid mechanics, structures and building systems, fluid dynamics and hydraulics, tribology, dynamic systems and control, and materials engineering and processing. These programs are formed from the former programs in Chemical and Process Engineering (CPE), Civil and Environmental Engineering (CEE), and Mechanical Engineering and Applied Mechanics (MEAM).

The proposed FY 1986 budget for each new program element is:

Solid Mechanics	$ 5.66M
Structures and Building Systems	4.40M
Fluid Dynamics and Hydraulics	5.40M
Tribology	2.04M
Dynamic Systems and Control	2.85M
Materials Engineering & Processing	3.30M
Total	$ 23.65M

An examination of this budget for FY 1986 indicates the following:

1. The total budget increase for the division for FY 1986 from FY 1985 is 2.7%, or about half the inflation rate.

2. The proposed FY budget for the division is 4% above the actual expenditures for FY 1984.

3. The proposed FY 1986 budget for the Fluid Mechanics and Hydraulics program is 7% below the actual expenditure for this program in FY 1984.

4. The proposed FY 1986 budget for the Dynamics Systems and Control program is 2% below the actual expenditure for this program in FY 1984.

5. The Solid Mechanics Program proposed for FY 1986 is 1% above its actual expenditures for FY 1984.

6. The Structures and Building Systems program proposed FY 1986 budget is 2% above its actual expenditure for FY 1984.

Given that each program has to support a specified number of Presidential Young Investigator Awards, the funds available for the support of research in most of the programs in this division are decreasing. Considering the increase in costs of supporting research it is possible that if these funding trends continue, the number of investigators and graduate students supported by these programs could be half of their 1984 levels by 1989.

Apparently, the priorities for engineering funding are in other divisions and programs. However, the budgetary trends in this division suggest some careful thinking about their long-term consequences. In particular, what effect will these trends will have on funding of high-risk research that may five years from now lead to breakthroughs that could have major impacts on U.S. competitiveness?

Engineering Science in Electrical, Communications and Systems Engineering:

The total of programs subsumed under this budget category are scheduled to grow by 5% in the new fiscal year, from $25.40 to $26.68 million. Within this subactivity, however, significant reallocations of funding levels are proposed:

	FY 1986	FY 1985	% Change
Solid State & Microstructures	$ 7.70M	$ 7.22M	+ 6.6
Communications Systems & Signal Processing	5.20	5.20	0.0
Systems Theory & Operations Research	5.20	5.00	+ 4.0
Quantum Electronics, Waves & Beams	4.60	5.00	- 8.0
Instrumentation, Sensing & Measurement	3.98	2.98	+33.6
Total	$26.68M	$25.40M	+ 5.0

As noted, funding levels for the first three subactivities are maintained at nearly level funding levels (after inflation) but a substantial increase of 33.6% (+1.0M) is planned for research on novel instrumentation and measurement systems. This field of research is one of the key objectives of the restructured Engineering Science Program. This program seeks to increase the science knowledge base on electrical phenomena leading to synthesis and analysis of instumentation devices, circuits and systems.

This subactivity combines many of the efforts formerly supported under the Electrical, Computer and Systems Engineering subactivity in the FY 1985 Budget Plan of NSF. Some elements of the former program are now found within the expanded elements of the new program for Science Base Development in Design, Manufacturing and Computer Engineering, and in the program for Emerging &

Critical Engineering Systems. These elements have been allocated to the latter program areas by reason of their closer relationship to the state of technology than to basic science. After taking these organizational changes into account, an additional growth in programs of approximately $1.0M can be identified for these programs in the FY 1986 Budget.

Critical and Emerging Technologies:

The NSF Budget is a clear statement by the Foundation that research on productivity will be emphasized. The Engineering Research Center and supercomputer thrusts were a beginning. The latest, and perhaps most critical directive, is the clear, and somewhat bold, move to apply critical support of $39M to this new thrust. The 10% increase for emerging and critical engineering systems is the third largest of the engineering subactivities. However, Design, Manufacturing and Computer Engineering, which has been identified as a critical and emerging area, shows a 19% increase. This aggregate puts a bold stamp on the foundation's focus for 1986.

There is no doubt that the research funded under these collective subactivities will have an impact on research directions for the next decade. NSF is accepting a major responsibility and challenge for the nation's future. This courage is needed and is to be applauded.

Cross Disciplinary Research:

This subactivity focuses the efforts of research teams on topics where the participation of individuals from several disciplines enhance the innovative character of relevant research. Industry/University research centers are funded at the same level in FY 1986 as FY 1985; industry/university research projects are decreased from $6.99 million in FY 1985.

The largest change is clearly in the engineering research center concept. It is anticipated that NSF funding will be committed to a select group of university centers for a period of five years. This funding philosophy will clearly establish centers at large research universities capable of assembling broadly-based research teams and with demostrated ability to administer programs of several million dollars per year. It is also evident that an increase in funding of approximately $10 million to $15 million per year until the desired number of centers has been established is a major commitment of NSF.

The NSF has been responsible, in part, for the orientation of research in universities of today. The ERC approach will alter this orientation in engineering. If so, the small-scale, individual-investigator research may be diminished unless budget additions are forthcoming for the science-based areas.

NSF must remain mindful of a need to continue contributions to the general health of academic research through traditional funding programs as well. The ERC concept is an innovative one. The technical community, and certainly the Congress, will be observing this phenomenon very carefully. A major investment of this nature must be proven as an appropriate research philosophy. NSF has a major challenge ahead to demonstrate that research teams and center grants enhance and support the knowledge base of vital engineering fields.

In keeping with the new more active role of NSF in defining national needs for engineering research, the ASME is ready and willing to assist in providing advice and counsel for the definition of long-range issues which may impact U.S. competitiveness in a wide range of engineering specialities. This is a role for which the ASME is well-equiped since we are already structured to address cross-discipline engineering interests within major industrial divisions. We have been active for many years in stimulating cross-disciplinary dialogues among our members in recognition of the fact that modern technology embraces many facets of the more traditional disciplines in science-based engineering specialities.

The new directions are admirable and the staff of the foundation are to be soundly applauded for their foresight in emphasizing engineering research and education. We trust that the Congress will endorse these efforts and further encourage the strengthening of basic engineering research which is the foundation of our technological future.

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Task Force on the
National Science Foundation
FY 1986 Budget

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TESTIMONY

NATIONAL SCIENCE FOUNDATION AUTHORIZATION

Committee on Science and Technology

of the

U.S. House of Representatives

Stephen R. Edwards,
Executive Director
Association of Systematics
Collections

20 February 1985

20 February 1985

-- TESTIMONY --
AUTHORIZATION OF THE NATIONAL SCIENCE FOUNDATION

The Association of Systematics Collections and The Associated Natural Science Institutions are pleased to provide testimony in conjunction with the authorization hearings for the National Science Foundation. We believe in, and support, the mission of the Foundation. The combined constituencies of our two organizations represent over 90% of the institutions and individuals in the United States that study whole organisms. Together, we represent between 8,000 and 10,000 individuals, over 30 scholarly societies, and nearly 200 institutions containing over 680,000,000 biological specimens.

The pure research supported through the National Science Foundation is an investment in our future -- society's overhead -- that assures that practical questions can be answered in the future, in a timely and credible manner. Our statement focuses on those biological research programs supported by NSF that emphasize studies of whole organisms and the institutions that provide the facilities necessary to undertake this research, e.g., biological collections, laboratory facilities, research equipment, and computers. Of particularly importance to our constituents are the Systematic Biology and Biological Research Resources Programs in the Division of Biotic Systems and Resources and the Anthropology Program in the Division of Behavioral and Neurosciences. However, significant funding in our community has been awarded from programs in Stratigraphy and Paleontology, Biological Oceanography, and International Programs. Most of these programs are administered in the Directorate of Biological, Behavioral, and Social Sciences. Our discussion of the significance of Anthropology Program is presented on page 5 of this document.

Before addressing the specific role these NSF programs play in our community, we would like to make two comments: the first concerns the role of museums and botanical gardens in research and graduate education; the second addresses the present status of the systematic biology community.

Research and graduate/undergraduate education in the biological sciences are not undertaken exclusively in universities. Slightly over 21% of those receiving funds awarded from recognized programs in NSF work in museums or botanical gardens, while museums and botanical gardens are responsible for maintaining nearly one-third of the biological collections. Almost 50% of the researchers in systematic biology rely on collections at insitutions other than their own for specimens used in their research. Therefore, congressional action concerning replacement of deteriorating and obsolete equipment in colleges and universities must be applied to museums and botanical gardens with established research and graduate programs (the latter through formal relationships with degree granting institutions).

Systematic biology -- the study of the relationships of organisms -- is a dynamic science that serves as the foundation upon which other biological disciplines are built and inquiries pursued. With the application of technologies from such diverse fields as mathematics, chemistry, physics, engineering, and computer science, systematics is enjoying a renaissance. Because names given to species by systematic biologists imply relationships with other organisms, the names are not fixed. As biologists learn more about organisms, the organism's names may change to reflect this new knowledge. Why is this important? Simply, the ability to achieve and repeat results in all research in other branches of biology (e.g., ecology, physiology, behavior, genetics, biochemistry) depends on identification and classifications provided by systematic biologists as a consequence of their studies of species and species relationships.

We believe that Congressional recognition of the pivotal role systematic biology plays in these three areas is extremely important to the future of biology in the United States, and the world. In support of the reauthorization of the NSF we describe the central position NSF programs hold to the larger research and development investment of our Federal government; the relationships such investments in research have on undergraduate and graduate education; and the influence research investments have on the communication of science to respond to societal needs. These three parameters are closely related and their separation is not as discrete as implied by the facts that follow.

Relationship of NSF Funding to Other Government Programs.

From the research community's perspective, during the five years from 1978 through 1982, a total of $165,000,000 (or $33,000,000 per year) was received by research museums and similar institutions in systematic biology. Of this amount over 82% was provided by Federal agencies; the National Science Foundation provided slightly less than 40% ($65,000,000 or $13,000,000 per year). Private sector support accounted for about 10% of the total funding. These funds take into account support for research as well as the necessary resources to undertake and sustain the research programs.

The National Science Foundation is the only Federal agency that is charged with underwriting these pure research activities. The Foundation's outstanding record of supporting quality research programs is, to a great extent, based on its utilization of the peer-review system through which the community itself participates in the selection and award process. All other federal agencies that invest in research directed to answering specific questions pertinent to the missions of their agencies must rely on the output of the pure research community before they can adequately address the problems facing them.

Research Support and Graduate/Undergraduate Education.

The relationship between the National Science Foundation and education at the graduate/undergraduate levels is less evident but extremely important. Research funding provides employment for students at both the graduate and undergraduate levels making it possible for students to cover their educational costs. More importantly, however, the work provides a remarkable educational experience from the standpoint of the scientific community. What better way to learn how to do research than to work on a research project? Since NSF support emphasizes pioneering studies that open new avenues of inquiry, this research internship is a vital supplement to traditional course work and a necessary final step in training new biologists.

Three-fourths of the graduate students in systematic biology have indicated that completion of their graduate training was dependent upon their receiving external financial support through teaching, research, or curatorial assistantships. Over 20% of the students working on Masters degrees and nearly 40% of those working on doctoral degrees received necessary financial support through research assistantships.

-- TESTIMONY --
AUTHORIZATION OF THE NATIONAL SCIENCE FOUNDATION

Support by the National Science Foundation enables many natural history museums and botanical gardens to conduct important predoctoral graduate programs. As degree granting universities transfer the trusteeship of natural science collections to museums and botanical gardens their graduate students in systematic biology, minerology, and anthropology, conduct their dissertation research projects at the museums and botanical gardens, the collections of which are supported by the Foundation. Graduate students contribute to the maintenance and preservation of systematic collections and they add significantly to the challanging intellectual climate in these institutions.

The quality of undergraduate education is also enhanced as a consequence of the research investment. Those receiving research funding, including the research assistants, are generally far better qualified to communicate their subject because they must know their subject extremely well in order to qualify for such funding. This is particularly important when looking ahead to the next generation of researchers in our discipline. Nearly 80% of the professionals in systematic biology today chose their field because of the influence of a key personality or a key course during high school or undergraduate college. People in our profession decide to do what they do because of their love for the organisms -- not because they will make a lot of money. Active researchers are crucial to the recruitment and training of new researchers.

We are certain that the research enterprise, in conjunction with the educational roles of the sponsoring insititutions (e.g., universities, colleges, museums, and botanical gardens) provide the cornerstone of science today, and more importantly the future. The research programs at the National Science Foundation are particularly important in catalyzing this process in our community.

Research Support and Communication of Science.

Communication of science in our community is accomplished in four ways: 1) publications, 2) instruction, 3) exhibits, and 4) responding to specific questions. Whether the subject is genetic engineering, environmental conservation, acid rain, species or habitat preservation, animal husbandry, or agriculture, basic knowledge of organisms is crucial to rational decisions.

Given the dominant influence of NSF supported research in our community, it is fair to assume that a large percentage of the published articles and books are a direct consequence of the NSF investment. Between 1978 and 1982 individuals in our community published over 20,000 peer-reviewed articles and over 1500 books. Over 40% of our constituent institutions sponsored publication series designed expressly to communicate the results of research studies. And over one-fourth of these institutions support publications that are specifically designed to communicate science to the public.

Instruction is accomplished in the traditional classroom model primarily associated with secondary schools and colleges or universities, as well as through short courses commonly offered by museums and botanical gardens that are designed for the interested public. Irrespective of the model employed, the quality of the educational experience is tied to the underlying research programs at the institution.

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Exhibits play an extremely important role in communicating research activities to the public in museums and botanical gardens. Gone are the days when a natural history exhibit was comprised of a stuffed animal. Today our constituents must maintain a dynamic exhibits program that communicates concepts in the natural sciences in order to meet the expectations of a sophisticated public. To keep the public aware of contemporary science, ideas for exhibits programs are derived from the research components of these institutions. Again, the research supported through the Foundation is very important to this process.

Finally, specific inquiries from the public concerning the natural sciences represent a significant contribution to the communication of science to the public. Inquiries range from "How do I get rid of the bats in my attic?" to "What organisms would be found in a particular area?" to "What is the name of a particular organism?" In any case, the answers to these questions are directly related to the research activities of our community.

In conclusion, to fulfill our responsibility to the public, it is essential that the Foundation provide support for long-term research projects that result in taxonomic revisions and monographs. This research emphasis will synthesize current knowledge of groups of organisms, thereby making higher level, synthesis-oriented, inquiries more cost effective in such fields as ecology, pest-control management, genetic engineering, etc. To complement such revisionary studies, it is essential that large scale floral and faunal surveys be implemented. Besides identifying the biota that have been heretofore unknown, data derived from such surveys will allow the community to be far more responsive to the public questions we are being asked to answer. In both cases the public investment will simultaneously serve to stimulate young students to select whole-organism biology as their profession.

Currently, those institutions (particularly museums and botanical gardens), that have a commitment to research in organismic biology, have extreme difficulty capitalizing specialized equipment that is necessary for more than one research project, e.g., scanning and transmission electron microscopes, computers, frozen tissue facilities. In most instances such equipment cannot be justified on the basis of a single research proposal, yet in the absence of such equipment, researchers in these institutions are no longer competitive for support. Likewise, support is needed for those collection facilities in major institutions that provide services for researchers throughout the United States. In many instances external demands on an institution far exceed the curators' capacity to respond. To discontinue such services would severely curtail whole-organism research and yet the institutions are finding it more difficult to fulfill this professional responsibility.

Anthropology

Finally, a word about collection based anthropology, which at NSF is in the Division of Behavioral and Neural Sciences. Museum specimens that represent man's heritage are deteriorating rapidly and badly need increased support. The administration's budget for anthropology is in the $5 million dollar range but less than 10% of that amount is invested in the preservation and conservation of natural history collections.

Anthropological collections, the material evidence of vanished and disappearing societies, are being consumed by neglect, albeit benign, in our institutions. At the root of this neglect is the lack of funds.

The stores of America's research museums must be protected and preserved: protected from the insects, bacteria and rodents that are devouring inadequately stored textiles and leather items; and preserved from the sunlight that fades the colors of dyes and paints made from extinct plants. Space is also a critical factor. Making breakage a constant threat, insufficient cupboards force delicate pottery or fragile basketry to be stacked and then crowded together. And large items, such as primitive machinery, boats and carts, are at risk of damage when they must be moved through narrow corridors and stairways.

Yet why is this material evidence so vital? Why is it more than mere curiosities that belong in the nation's attics? Material evidence provides a remarkably objective way for scientists to study man's variety, limits and possibilities. The history of humans and human societies, the evolution of human cultures and their diversity can be derived in several ways. Oral tradition and the written record are two obvious ways. But a third way is through observation, cataloguing and study of the objects made and used in a society. Oral and written history may reflect the biases of their originator, their translator, and their interpreter. Material evidence has the advantage of objectivity at least as a source; only the interpreters may impute their own biases to objects.

New scientific technologies for interpretation, such as radioactive carbon dating, classification in computer data bases, and accessibility through modern communication systems have put a premium on material evidence as a scientific research resource.

~~And~~ in the future, we may expect that more developments will render material evidence even more valuable. However, the rapid deterioration of items when storage facilities do not have proper space, humidity, temperature and light control means that many of these irreplaceable items may be lost to future scholarship. Moreover, when museum budgets do not support well-trained personnel, sufficient in number, items are not accessible for research.

An additional problem is posed by a growing increase in value of archeological and anthropological artifacts in the commercial art market. This factor renders them liable both to theft and to sale by financially hard-pressed museum directors. These two threats to the stock of material evidence available for scientific research in this country are closely tied to lack of funding: security systems and personnel are expensive; an adequate financial base would obviate the necessity to sell irreplaceable items to support salaries and other programs.

Thus, in order to preserve our artifacts and museum treasures so that we and our descendants may solve some of mankind's riddles, we must make an investment -- an investment in saving the material evidence of the past, and thereby understanding ourselves, our predecessors and, possibly, our future.

We are grateful to the Committee for giving us this opportunity to express our views. If the Committee should desire further information or data, please contact my office.

CONSORTIUM OF SOCIAL SCIENCE ASSOCIATIONS
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STATEMENT OF THE CONSORTIUM OF SOCIAL SCIENCE ASSOCIATIONS (COSSA)

David Jenness
Executive Director

on the
FY 1986 BUDGET FOR THE NATIONAL SCIENCE FOUNDATION

Prepared for the
SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

The Honorable Doug Walgren, Chairman

March 15, 1985

American Anthropological Association • American Economic Association • American Historical Association • American Political Science Association
American Psychological Association • American Sociological Association • American Statistical Association
Association of American Geographers • Association of American Law Schools • Linguistic Society of America

The Consortium of Social Science Associations (COSSA) represents more than 175,00 American scientists across the full range of the social and behavioral science disciplines, functioning as a bridge between the academic research community and the Washington community. A list of COSSA Members, Affiliates, and Contributors is attached.

COSSA would like to take this opportunity to comment on the proposed budget for the National Science Foundation (NSF) for FY 1986. We believe the budget prepared by the Foundation is, for the most part, a good one. The 4.4% increase for NSF as a whole reflects the continuing commitment of this administration to basic research. In this era of budget constraints imposed by the size of the federal deficit, it is important to maintain the nation's investment in basic research. Without this investment by the Foundation, much of the research conducted in the social and behavioral sciences would lose its source of funding and the quality of our science and inventiveness would decline. Since social science is basic to understanding our economy and to the efficient operation of the industrial sector, one offshoot of such a decline would be to endanger the U.S. economy, innovation and productivity, and our competitive position in the world market.

COSSA is pleased with the 7% increase in the Research and Related Activities function for FY 1986. We strongly urge the maintenance of that increase during the Subcommittee's deliberations. Naturally we are heartened by the significant increase proposed for the social and behavioral sciences in the FY 1986 budget. The $5.4 million or 19% increase in the Division of Social and Economic Science reflects the long uphill climb from the nadir of the 1981-83 budget reductions in this area. Although one program has been eliminated, all other programs show good to excellent progress. The increase of 6% in the Division of Behavioral and Neural Science for behavioral science programs continues the substantial increases that occurred last year. The interest of the Congress in teaching and learning research is reflected in the funding for these programs.

The increases in both these divisions indicate a recognition by NSF of the intellectual vitality and ferment in these disciplines. It is also important to point out that for most of these disciplines NSF is the major, and sometimes sole, source of support for basic research. For example, research in physical geography receives no support elsewhere in the public or private sectors, while NSF provides 95% of federal support for basic academic research in political science, and in some disciplines 90% of federal support for social measurement and analysis. Even in economic science, if the Economic Research Service of the U.S. Department of Agriculture is excluded, NSF provides the major portion of federal funding.

Although the increases are substantial in this tight budget year, the social and behavioral sciences at NSF still remain below their FY 1980 levels in real dollars. More importantly, the proportion of the total NSF research budget going to these programs has decreased since FY 1980 and remains only 4.1 percent of that budget.

The major increase for social and behavioral science comes in the economics program. Part of that increase comes from the transfer of ongoing projects from the Regulation and Policy Analysis program which has been eliminated. The elimination of this program is not that disturbing to COSSA as long as the commitment to this research is supported in other programs at the Foundation and that this is not a harbinger of future attempts to abolish whole programs. The increase in economics also stems from a recognized national need for better data collection and analysis in the areas of international trade, productivity and economic growth. Furthermore, increased support in economics will lead to greater research on microeconomic questions which often get lost in the search for answers to large macro fiscal and monetary problems.

Large increases in the Geography and the History and Philosophy of Science (HPS) programs reflect the intellectual vitality of the research in these areas. Geography is forging new ties to other sciences -- notably the earth sciences. The HPS program is a growth stock intellectually and has the distinctive role of helping to keep all the sciences self-critical. As scientific and technological growth explode around us it is important to remember past discoveries and track new ones.

Past recognition by the Congress of the importance of teaching and learning research, exemplified by increased support for this research in FY 1985, should be recognized again in FY 1986. Support for understanding how people learn and retain information should remain a high priority for basic research in the behavioral sciences. COSSA, however, believes that funding for this research is provided best within the research programs at NSF and not in the programs in the Science and Engineering Education (SE&E) Directorate at the Foundation. While it is important to understand more about science education as a process and an area of practice, techniques and methods for improving science education always need fundamental research in a deliberate manner to produce meaningful results. Only such research, for example, will illuminate cognition and motivation. For this reason we are concerned with any attempts to increase funding for SE&E at the expense of the basic research budget.

The elimination of the Ethics and Values in Science and Technology (EVIST) program has disturbed many in the social and behavioral science community. COSSA believes that this program has served important purposes in the past. It has created a necessary visible commitment to the issue of the ethical and moral impacts of the nation's scientific and technical advances. We urge that research in this area now be supported in the existing programs at the Foundation.

COSSA strongly believes that social and behavioral science research plays a significant role in helping to understand national problems. While solutions to those problems sometimes escape us, we provide decision-makers, whose judgments are necessary to develop those solutions, the information to make those judgments. Let us cite a few examples:

On the issue of the changing rural/urban pattern of life in the United States that impact on domestic program decisions such as aid to states and localities -- demographers have noted the internal migration patterns that precipitated the change; labor and agricultural economists have focused on the impacts of those changes on the rural and urban work forces; geographers have explored the impact of these changes on business development; and sociologists have examined the impacts of the changes on community life, both rural and urban.

On the issue that is becoming increasingly prevalent in America, the aging of our population -- economists have examined the implications of investments in different age groups (e.g. educational finance viewed contrastively with Medicare and Social Security or with job retraining); social psychologists have probed the social relations across age-defined groups; sociologists, psychologists, economists and political scientists have all investigated how the aging of America will impact on the nation's social, economic and political future.

Data from NSF-sponsored data collection efforts are being used by social scientists to evaluate participation in government programs, sources of income, labor force status, political participation, voting behavior, public opinion on issues, and life-style behaviors.

With respect to the issue of the importance of higher education and its costs to the Federal government -- sociologists, economists and psychologists know a good deal about the role of higher education in social mobility and social stratification; about class and other subcultural differences in motivation and achievement; and about subjective life satisfaction as related to education, career and 'life chances.'

The issue of immigration is one of the toughest that the Congress has dealt with over the past few years. Social scientists have examined this issue as regards resettlement, cultural adjustment, linguistic and educational programs, ethnic history, job patterns and political participation.

Congress' enactment of legislation creating the U.S. Institute of Peace suggests an interest in researching methods of conflict resolution. Further support for this research would allow the bringing together in an interdisciplinary manner the social and behavioral research on the impact of competing world economies, the dynamics of large organizations, individual rivalry and cooperation, social dynamics, and anthropological and foreign-area knowledge.

Furthermore, as the nation focuses on the need for innovation and increased productivity, let us not forget the contributions of social and behavioral science to that effort. As Frank Press, President of the National Academy of Sciences, has noted, social science has provided American business the tools which the private sector often relies upon to make its decisions. Sample surveys, human factors, reinforcement theory, organization theory, and many other concepts derived from basic social and behavioral science research have been applied to the everyday world of American business.

This Subcommittee has not forgotten those contributions in the past and COSSA is grateful for its previous actions on the NSF budget for the social and behavioral sciences. This year we urge the Subcommittee to support the proposed increases in the research budget at the Foundation and to resist attempts to dilute the commitment to basic research presented in the FY 1986 budget.

Thank you for the opportunity for COSSA to present its views.

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Southwestern Social Science Association
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TESTIMONY OF

William F. Prokasy, Ph.D.

President

Federation of Behavioral, Psychological and Cognitive Sciences

on the subject of

NATIONAL SCIENCE FOUNDATION AUTHORIZATION

Fiscal Year 1986

prepared for

SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY

COMMITTEE ON SCIENCE AND TECHNOLOGY

UNITED STATES HOUSE OF REPRESENTATIVES

The Honorable Doug Walgren, Chairman

March 15, 1985

American Educational Research Association • American Psychological Association • Cognitive Science Society • Human Factors Society •
International Society for Developemental Psychobiology • National Academy of Neuropsychologists • Psychometric Society • Psychonomic Society •
Society for Computers in Psychology • Society for Mathematical Psychology • Society for Psychophysiological Research •
Society for Research in Child Development • Society of Multivariate Experimental Psychology

I am William F. Prokasy, President of the Federation of Behavioral, Psychological, and Cognitive Sciences. The Federation, established in 1980, is a coalition of 13 scientific societies with combined memberships of over 90,000 scientists. The Federation's interests include research on behavioral, psychological and cognitive processes and their physiological bases, including health, education, and human development. Thank you for the opportunity to comment on the FY86 authorization for the National Science Foundation (NSF).

Overall, we are pleased with the proposed FY86 budget for NSF. As scientists, we are pleased with the Administration's active support for the funding of basic research by the Federal government. This is reflected in the request by the 7% increase in NSF's Research and Related Activities over FY85 levels. It is important to the nation to maintain a strong Federal role in basic research within the constraints imposed by deficit reduction efforts. In this testimony I will discuss past and current research in the behavioral and cognitive sciences and research in science education. I will also suggest some future research agenda items. Finally, I will draw the committee's attention to NSF's program on Ethics and Values in Science and Technology.

Behavioral and Cognitive Sciences

Funding of the behavioral and cognitive sciences in the Administration's budget is consistent with the nation's needs and the scientific capabilities of the research force in behavioral and cognitive sciences. The nation faces serious difficulties in adjusting to new information technologies in the work place and in finding productive ways to utilize new technologies to increase the productivity of our industrial and educational institutions. Results of research in behavioral and cognitive sciences that are already available could be used more effectively in design of new human-machine systems, development of programs of training and education, and improvement of the organization of human relations in working institutions. For the future, continued improvements in the use and development of technology will require solutions of fundamental scientific problems regarding the nature of human understanding, learning, and motivation. The National Science Foundation's support of basic research on these problems is very important.

Let me continue by pointing to some specific past and current successes. Recent research has shown ways in which human judgment and decisions are distorted by fundamental misconceptions of the likelihoods of events that are uncertain. Using theoretical and empirical research on visual perception, fundamental advances have been made in identifying ways in which the visual system processes physical and neural information to provide information about objects. Significant progress has been made in developing rigorous theoretical descriptions of thinking processes involved in "intuitive" understanding of language and of events and systems in the environment.

Recent findings provide the basis for much new and exciting research. For example, how can we assure that policy decisions reflect the beliefs and values of individuals? Current research in decision making is helping us to characterize these situations in a way which maximizes concordance between policy decision and individual values. How does the mind structure information about objects in the environment? Work in visual perception is providing impressive tools for addressing this important question, tools which ultimately should influence how we educate our young people. Scientific progress in understanding thought processes will contribute critically to the design of computer-based visual displays as we become increasingly dependent on electronic graphics for communication. Characterizations of the mental models that people use in reasoning provide a basis for more adequate design of technical information systems and of training in the use of technical systems.

These and numerous other contributions of behavioral and cognitive research have been recognized repeatedly by the scientific community and in studies of major national problems. Two briefings have been prepared by the National Academy of Sciences for the President's Science Adviser that document fundamental advances in understanding language, thinking and learning in mathematics and science, principles of the organization of knowledge and cognitive expertise, basic processes of perception, and applications of new technologies in education. A symposium organized by the National Academy of Sciences on Basic Research in Behavioral and Social Sciences, included surveys of significant recent progress in understanding processes of decision and judgment in uncertain situations, the nature of information that determines perception of objects, and the intellectual capabilities of young children. The report of the National Science Board Commission on Education in Mathematics, Science, and

Technology includes a survey of important recent research findings relevant to education and technical training, and urges a strong continuing commitment to basic and applied research on processes of learning and teaching. The Federation office will be glad to provide you with any of these references.

Science Education

Mr. Chairman, we wish to commend the leadership role you and this Subcommittee are taking in an area of major concern to us: Science Education. The need for strengthening our nation's educational programs in mathematics, science and technology is broadly recognized. In turn, this means that we need to improve our understanding of the processes of problem solving, comprehension, learning, teaching, and testing to guide the development of new educational resources, including effective use of new computational technology in both instruction and testing.

The present budget recognizes the role that both the Science and Engineering Directorate (SEE) and the Biological, Behavioral and Social Sciences Directorate (BBS) have in research in science education. We support joint efforts by behavioral and cognitive scientists, content area scientists, and science educators. We also urge that efforts at SEE and BBS be adequately supported.

To illustrate the importance of that support, let me trace some of the past and current cognitive science research in teaching and learning. Research on problem solving has provided significant new information about the cognitive processes and knowledge that are needed to use the formal knowledge of science and mathematics. Typically, in mathematics and science teaching, formulas and computational procedures are explained directly, but use of those formal procedures for solving problems is treated implicitly, using examples but little or no direct instruction about problem-solving methods. Recent findings have demonstrated the kinds of knowledge required for successful problem-solving, and have provided explicit descriptions of the knowledge relevant to selected domains in science and mathematics.

A predominant current view underlying curriculum design and teaching in science is that student's understanding of scientific concepts is shaped by their instruction. Much care is taken to avoid presenting incorrect or misleading information so students will not need to unlearn incorrect principles or concepts. However, students begin their study with strongly held conceptions of the phenomena that are explained by scientific principles, and their preconceptions are often inconsistent with the principles to be learned. These misconceptions often persist even after a considerable amount of instruction in science. Students may be able to use their formal knowledge to correctly solve textbook problems, but still base their understanding of events of the world on their incorrect preconceptions.

Many of the research findings are important for educational practice. Recent information about the sources of difficulty in understanding mathematical, scientific, and technical concepts provides a basis for development of educational materials and methods for reaching a broader group of students. Research to identify factors contributing to relatively low levels of participation in mathematics and science courses by women and members of minority groups is underway, and has suggested ways in which increased participation can be encouraged.

Research in cognitive science is not only changing our views of how people learn science and mathematics, it is also shaping a theory of learning in which content plays a central role. The approach implies that much of the research in teaching and learning in science will be done in the context of the science being taught.

Education for a technological world must become a concern of our educational process. For that reason, we need to understand more about the cognitive skills and knowledge required for successful performance and understanding in technical domains. We need to study how people understand technological systems in order to assure that they are designed optimally for human use and comprehension.

As with any science, research relevant to education in mathematics, science, and technology is cumulative. It requires continuing support if it is to sustain and expand its impact in education. Without continued NSF support the current momentum will be greatly diminished.

Ethics and Values in Science and Technology(EVIST)

We are disturbed by the elimination of EVIST. We believe that a visible program on the moral and ethical issues in science and technology is important. The importance of these issues is recognized by many major universities (e.g. University of Illinois, MIT, Stanford) where related academic and research programs on the meaning of science and technology in our society are being developed. Concern for the ethics and mores of our current technological revolution is shared by our leading scientists. It is important that research in this area be supported. As scientists we are often too close to our own research to evaluate the ethical issues, and for that reason we believe that the most effective way of funding such research is in a separate and visible program at NSF. A separately funded program targeted for research in ethics will aid in incorporating the ethical and moral issues involved in research and development in the education of our youth. We urge that this small program be reinstated.

Conclusions

In general, we are pleased with the proposed FY86 NSF budget. We share with you the belief that consistent Federal funding of science is of national importance. It is important to the vitality of our universities, to the training of future generations of scientists, and the pursuit of knowledge. We are grateful for the support this Subcommittee has given to the behavioral and social sciences. We urge the Subcommittee support the proposed increases in the behavioral and social science research budget at NSF. We request that the FY86 funding level for Science and Engineering Education be carefully considered, and we ask the Subcommittee to evaluate the role of EVIST and restore it.

Please do not hesitate to call on me or the Federation staff if we can be of further assistance during your deliberations. Thank you.

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